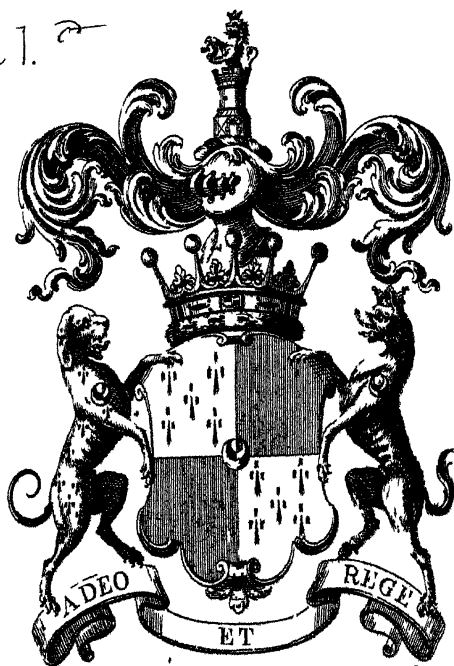


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*Philip Earl Stanhope*

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AGRICULTURAL RESEARCH INSTITUTE

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VOL. L. PART II. For the Year 1758.

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LIX. *An Account of the Effects of Electricity in paralytic Cases. In a Letter to John Pringle, M. D. F. R. S. from Benjamin Franklin, Esq; F. R. S.*

S I R,

Read Jan. 12, 1758. **T**HE following is what I can at present recollect, relating to the effects of electricity in paralytic cases, which have fallen under my observation.

Some years since, when the news-papers made mention of great cures performed in Italy or Germany, by means of electricity, a number of paralytics were brought to me from different parts of Pennsylvania, and the neighbouring provinces, to be electrified; which I did for them at their request. My method was, to place the patient first in a chair, on an electric stool, and draw a number of large strong sparks from all parts of the affected limb or side. Then I fully charged two six-gallon glass jars, each of which had about three square feet of surface coated; and I sent the united shock of these thro' the affected limb or limbs; repeating the stroke commonly three times each day. The first thing observed was an immediate greater sensible warmth in the lame limbs, that had received the stroke, than in the others: and the next morning the patients usually related, that they had in the night felt a pricking sensation in the flesh of the paralytic limbs; and would sometimes shew a number of small red spots, which they

supposed were occasioned by those prickings. The limbs too were found more capable of voluntary motion, and seemed to receive strength. A man, for instance, who could not the first day lift the lame hand from off his knee, would the next day raise it four or five inches, the third day higher ; and on the fifth day was able, but with a feeble languid motion, to take off his hat. These appearances gave great spirits to the patients, and made them hope a perfect cure ; but I do not remember, that I ever saw any amendment after the fifth day : which the patients perceiving, and finding the shocks pretty severe, they became discouraged, went home, and in a short time relapsed ; so that I never knew any advantage from electricity in palsies, that was permanent. And how far the apparent temporary advantage might arise from the exercise in the patients journey, and coming daily to my house, or from the spirits given by the hope of success, enabling them to exert more strength in moving their limbs, I will not pretend to say.

Perhaps some permanent advantage might have been obtained, if the electric shocks had been accompanied with proper medicine and regimen, under the direction of a skilful physician. It may be, too, that a few great strokes, as given in my method, may not be so proper as many small ones ; since, by the account from Scotland of a case, in which two hundred shocks from a phial were given daily, it seems, that a perfect cure has been made. As to any uncommon strength supposed to be in the machine used in that case, I imagine it could have no share in the effect produced ; since the strength  
of

of the flock from charged glaſs is in proportion to the quantity of ſurface of the glaſs coated ; ſo that my flocks from thoſe large jars muſt have been much greater than any, that could be received from a phial held in the hand.

I am, with great reſpect,

S I R,

London,  
Dec. 21, 1757.

Your moſt obedient Servant,

R. Franklin.

*LX. Observations on the late Comet in September and October 1757 ; made at the Hague by Mr. D. Klinkenberg : In a Letter to the Rev. James Bradley, D. D. Aſtronomer Royal, and F. R. S, and Member of the Royal Academy of Sciences at Paris. Translated from the Low Dutch.*

S I R,

Read Jan. 12,  
1758.

I Hope you will be pleaſed to excuse the liberty, which I take, of troubling you with my obſervations on the comet, which made its appearance here, and in other parts of Europe, in the months of September and October laſt ; and which, according to the news-papers, was firſt obſerved the 11th September by Mr. Gartner, at Dorkkeurtz near Dresden ; then by me, on the 16th



of the said Month, here in the Hague ; and afterwards in different places. As I find, that you have observed the comet, I doubt not but that you have done it in the most accurate manner ; and my great love for this science induces me to beg, that I may have the happiness of knowing some of your observations. My good friend Mr. Struyk at Amsterdam wrote me some time ago, that he intended to ask the same favour of you ; but I have not since heard any further from him. I observed this comet from Septemb. 16th in the morning, until Octob. the 11th in the morning ; and found its situations, according to my method, as follows :

							Longit.	Latit.
1757.							$10^{\circ}$	$10^{\circ}$
Sept. 16.	at	$\frac{1}{4}$ h.	ante mer.	The comet in	$\S$	$10^{\circ}$	15	with $10^{\circ}$
17	—	3	—	—	—	$\S$	14	7
18	—	$3\frac{3}{4}$	—	—	—	$\S$	18	10
19	—	4	—	—	—	$\S$	22	1
22	—	$2\frac{3}{4}$	—	—	—	$\Omega$	3	46
23	—	4	—	—	—	$\Omega$	7	36
25	—	$4\frac{1}{4}$	—	—	—	$\Omega$	14	50
28	—	4	—	—	—	$\Omega$	24	22
Oct. 1	—	$4\frac{3}{4}$	—	—	—	$\nearrow$	2	46
4	—	$4\frac{1}{2}$	—	—	—	$\nearrow$	9	45
9	—	$4\frac{1}{2}$	—	—	—	$\nearrow$	20	20
11	—	5	—	—	—	$\nearrow$	24	46
								3 9
								North.
								9 38
								8 57
								8 17
								6 15
								5 24
								4 6
								1 41
								0 12
								South.
								1 30
								2 40

But the two last observations will, in my opinion, differ the most ; because, when I made them, I was in some doubt about the adjustment of my instruments ; and the comet was then far advanced into the morning rays. I have, since the month of February last to the end of May, made fundry observations on fixed stars, with a telescope of 16 inches, made by Mr. Short ; and with a pendulum clock, made after the manner of Mr. Graham, by Mr. Vrythoff of this

this place. In the months of February and March, by a medium of eight observations, I found, that by the clock, the star Rigel. in every daily revolution, passed 4 min.  $2\frac{4}{9}$  seconds of time earlier, in the telescope; and in the latter end of May I found, by six observations, (the clock not in the least changed or altered) on the star Spica Virginis, that that star, in every revolution, passed 4 min.  $5\frac{1}{25}$  sec. earlier, in the same telescope; which intervals differ pretty nearly  $2\frac{3}{5}$  seconds of time from one another. Whether this difference arises from any defect in the clock, or whether it proceeds from any small difference of velocity of the earth's motion round its axis, I would have been very glad to have endeavoured to find out by farther inquiry, had not the death of Mr. S. Koenig intervened, and I thereby hindered from continuing my observations. The above observations were taken in the observatory of his illustrious Highness the minor Prince of Orange and Nassau, &c. &c. under the direction, and with the approbation of the aforesaid Mr. Koenig. After the death of that gentleman, I petitioned her Royal Highness the Princess Governess of these Provinces, &c. that I might have leave to continue my astronomical observations; but as yet I have not been able to obtain her Royal Highness's permission: otherwise I would have observed this last comet with more exactness. Had I been able to pursue the above-mentioned observations, I would, for the greater certainty in regard to the pendulum, have made use of a farther precaution. By means of a stove, with the help of a thermometer, I would have endeavoured to have kept the room (in which the clock stood) in the winter, and

at all times, in the same degree of heat it had at the time I made the observations in the summer. I would also have daily observed and noted the moon's place, at the time of the observations. Tho' this is but a slight observation of mine; yet I make no doubt, but that in case, by the different distances of the earth from the sun, and the different distances and situations of the moon with respect to the earth, and the respective effects produced by these causes, any inequality arises in the velocity of the diurnal motion of the earth on its axis, you (who have made the most sublime observations on the aberration of the fixed stars, and more than any mortal ever did before) must have discovered, and are well acquainted, with the same.

As my above-mentioned observations on the comet appeared too incorrect to undertake a calculation for the ascertaining of its path from the theory, I contented myself with effecting it by a construction. By this means I found, on a figure, whose globular or spherical diameter was  $13\frac{1}{2}$  Rhineland inches, as follows:

That the comet was in its perihelion the 21st of October, at two of the clock in the afternoon: the place of the perihelion 3 degrees in Leo. The comet's distance in the perihelion from the sun was about 34 parts, whereof 100 make the mean distance between the sun and the earth. The inclination of the comet's orbit with the ecliptic 13 degrees; and the southern latitude of the perihelion also 13 degrees: the ascending or north node  $82\frac{1}{3}$  degrees in Scorpio; and the comet's motion direct, or according to the order of the signs of the zodiac. On this supposition

tion I have, for some of the times of observations, estimated the apparent places of the comet, and found them as follows :

					Long.	Latit.
Sept. 18, at $3\frac{3}{4}$	ante	merid.	In	☉	$18\frac{1}{2}$	and 9 deg. North.
19 — 4	—	—	—	☉	22	$8\frac{2}{3}$
22 — $2\frac{3}{4}$	—	—	—	☉	$3\frac{1}{2}$	$6\frac{1}{4}$
23 — 4	—	—	—	☉	$7\frac{1}{2}$	$5\frac{1}{2}$
25 — $4\frac{1}{4}$	—	—	—	☉	$14\frac{2}{3}$	4
28 — 4	—	—	—	☉	$24\frac{1}{3}$	$1\frac{2}{3}$
Oct. 4 — $4\frac{1}{2}$	—	—	—	☿	$9\frac{1}{2}$	2 — South.
9 — $4\frac{3}{4}$	—	—	—	☿	$19\frac{2}{3}$	$3\frac{2}{3}$
11 — 5	—	—	—	☿	$23\frac{1}{8}$	$3\frac{2}{3}$

The observations, which I have taken, to ground the measurement on, are those of the 16th and 23d of September, and of the 1st of October. It appears very evident, not only from this rough calculation, but every other circumstance of this comet, that it is not the same with that in the year 1682: which, on certain accounts, is very desirable to be known; for both here, and in other parts of the Netherlands, there have been some people, who have published mere conjectures; and have ventured (very minutely and exactly, as they pretended) about the time that this comet first made its appearance, to predict the return of the comet of the year 1682. But by the above, the weakness of their pretensions is very evident to all the world: whereas, if this had proved to be the expected comet, they would have assumed to themselves much undue praise, and have pretended to knowledge even superior to the every-where much celebrated Newton and Halley.

It appears also probable to me, that this comet is none of those already calculated, or brought upon a list, by Messieurs Halley and Struyk. It is somewhat remarkable,

remarkable, that the line of the nodes is almost at right angles with the long axis of the ellipsis; which corresponds nearly with the comets of the years 1580, 1683, and 1686: but those had their perihelions northward of the ecliptic; whereas the perihelion of the last, which we have lately seen, was to the southward of the ecliptic.

I have the honour to subscribe myself, with the most perfect esteem for you, and your sublime studies, very respectfully,

S I R,

Your very humble and obedient Servant,

Hague, 13th Dec.  
1757.

D. Klinkenberg.

LXI. *Remarks on the different Temperature of the Air at Edyftone, from that observed at Plymouth, between the 7th and 14th of July 1757. By Mr. John Smeaton, F. R. S.*

S I R,

Read Jan. 12,  
1758.

ON the reading of Dr. Huxham's letter at the last meeting, some observations occurred to me, concerning the different temperature of the air, which I had observed at the Edyftone, from what had been observed by the Doctor at Plymouth, between the 7th and 14th of July

July last: which having been desired by some members to be put into writing, I beg leave to trouble you with the following.

Edystone is distant from Plymouth about 16 miles, and without the head-lands of the Sound about 11.

The 7th and 8th were not remarkable at Edystone for heat or cold: the weather was very moderate, with a light breeze at east; which allowed us to work upon the rock both days, when the tide served.

About midnight, between the 8th and 9th, the wind being then fresh at east, it was remarkably cold for the season, as I had more particular occasion to observe, on account of a ship that was cast away upon the rocks. The wind continued cold the 9th all day; which was complained of by some of the shipwrecked seamen, who had not time to save their cloaths; and so fresh at east, as prevented our going near the rocks, or the wreck; and so continued till Sunday the 10th; when, seeing no prospect of a sudden alteration of weather, I returned to Plymouth in a sailing boat, wrapped up in my thick coat. As soon as we got within the headlands, I could perceive the wind to blow considerably warmer; but not so warm as to make my great coat uneasy. Having had a quick passage, in this manner I went home, to the great astonishment of the family to see me so wrapped up, when they were complaining of the excessive heat: and indeed, it was not long before I had reason to join in their opinion.

This heat I experienced till Tuesday the 12th, when I again went off to sea, where I found the air

very temperate, rather cool than warm ; and so continued till Thursday the 14th.

In my journal for Wednesday the 13th I find the following remarks, *viz.* " This evening's tide" (from 6 A. till 12 A.) " the wind at east, but moderate, " with frequent flashes of lightning to the south-ward. Soon after we got on board the store-veffel, a squall of wind arose from the south-west on a sudden, and continued for about a minute ; part of which time it blew so hard, we expected the masts to go by the board : after which it was perfectly calm, and presently after a breeze returned from the east."

And in the journal of the 14th is entered, " This morning's tide" (*viz.* from 1 M. to 1 A.) " the air and sea quite calm."

Hence it appears, how different the temper of the air may be in a small distance ; and to what small spaces squalls of wind are sometimes confined.

It may not be amiss further to observe upon this head, that once, in returning from Edystone, having got within about two miles of the Ramhead, we were becalmed ; and here we rolled about for at least four hours ; and yet at the same time saw vessels, not above a league from us, going out of Plymouth Sound with a fresh of wind, whose direction was towards us, as we could observe from the trim of their sails ; and as we ourselves experienced, after we got into it by tacking and rowing.

I am, Sir,

Your most humble Servant,

Furnival's-Inn Court,  
12th Jan. 1758.

J. Smeaton.

LXII. *An Account of the Earthquake felt in the Island of Sumatra, in the East-Indies, in November and December 1756. In a Letter from Mr. Perry to the Rev. Dr. Stukeley, dated at Fort Marlborough, in the Island of Sumatra, Feb. 20. 1757. Communicated by the Rev. Wm. Stukeley, M. D. F. R. S.*

Read Jan. 12, 1758. **T**HE earthquake at Lisbon, which you gave me an account of, was certainly the most awful tremendous calamity, that has ever happened in the world. Its effects are extremely wonderful and amazing; and it seems, as you observe, to have been felt in all parts of the globe. On the 3d day of the same month the earthquake of Lisbon happened, I felt at Manna (1) a violent shock myself; and from that time to the 3d of December following I felt no less than twelve different shocks, all which I took an exact account of in my pocket-book. Since which we have had two very severe earthquakes, felt, we believe, throughout this island (2). The walls of (3) Cumberland-house \* were greatly damaged by them. Salop-house \*, my own (formerly Mr. Massey's), the houses

(1) Manna lies about 50 miles to the southward of Marlborough.

(2) The island of Sumatra is between 7 and 800 miles long from north to south.

(3) Cumberland-house is a new well-built house for the governor of the place.

\* N. B. Both these are contiguous to the fort.



of Laye (4) and Manna, were all cracked by them ; and the works at the sugar-plantation (5) received considerable damage. The ground opened near the *qualloe* (6) at Bencoolen, and up the River in several places ; and there issued therefrom sulphureous earth, and large quantities of water, sending forth a most intolerable stench. Poble Point (7) was much cracked at the same time ; and some *doosoons* (8) in-land at Manna were destroyed, and many people in them.

These are all the ill effects, that have come to our knowlege ; but, it is reasonable to suppose, not all the damage, that has happened upon the island.

### LXIII. *Concerning the Fall of Water under Bridges.* By Mr. J. Robertson, F.R.S.

Read Jan. 19, 1758. **S**OME time before the year 1740, the problem about the fall of water, occasioned by the piers of bridges built across a river, was much talked of at London, on account of the fall that it was supposed would be at the new bridge to be built at Westminster. In Mr. Hawksmore's and Mr. Labelye's pamphlets, the former published in 1736,

(4) Laye house or factory is about 30 miles to the northward of Marlborough, and Manna house or factory fifty miles to the southward.

(5) The sugar-plantation is five or six miles from Marlborough.

(6) The *qualloe* is the country word for a river's mouth.

(7) Poble Point lies about three leagues to the southward of Marlborough.

(8) *Doosoons* are villages.

1736, and the latter in 1739, the result of Mr. Labeyrie's computations was given: but neither the investigation of the problem, nor any rules, were at that time exhibited to the public.

In the year 1742 was published Gardiner's edition of Vlacq's Tables; in which, among the examples there prefixed to shew some of the uses of those tables drawn up by the late William Jones, Esq; there are two examples, one shewing how to compute the fall of water at London-bridge, and the other applied to Westminster-bridge: but that excellent mathematician's investigation of the rule, by which those examples were wrought, was not printed, altho' he communicated to several of his friends copies thereof. Since that time, it seems as if the problem had in general been forgot, as it has not made its appearance, to my knowlege, in any of the subsequent publications. As it is a problem somewhat curious, tho' not difficult, and its solution not generally known (having seen four different solutions, one of them very imperfect, extracted from the private books of an officer in one of the departments of engineering in a neighbouring nation), I thought it might give some entertainment to the curious in these matters, if the whole process were published. In the following investigation, much the same with Mr. Jones's, as the demonstrations of the principles therein used appeared to be wanting, they are here attempted to be supplied.

#### PRINCIPLES.

- I. *A heavy body, that in the first second of time has fallen the height of a foot, has acquired such a velocity,*

*velocity, that, moving uniformly therewith, will in the next second of time move the length of 2 a feet.*

II. *The spaces run thro' by falling bodies are proportional to one another as the squares of their last or acquired velocities.*

These two principles are demonstrated by the writers on mechanics.

III. *Water forced out of a larger chanel thro' one or more smaller passages, will have the streams thro' those passages contracted in the ratio of 25 to 21.*

This is shewn in the 36th prop. of the 2d book of Newton's Principia.

IV. *In any stream of water, the velocity is such, as would be acquired by the fall of a body from a height above the surface of that stream.*

This is evident from the nature of motion.

V. *The velocities of water thro' different passages of the same height, are reciprocally proportional to their breadths.*

For, at some time, the water must be delivered as fast as it comes; otherwise the bounds would be overflowed.

At that time, the same quantity, which in any time flows thro' a section in the open chanel, is delivered in equal time thro' the narrower passages; or the momentum in the narrow passages must be equal to the momentum in the open chanel; or the rectangle under the section of the narrow passages, by their mean velocity, must be equal to the rectangle under the section of the open chanel by its mean velocity.

Therefore

Therefore the velocity in the open chanel is to the velocity in the narrower passages, as the section of those passages is to the section of the open chanel.

But the heights in both sections being equal, the sections are directly as the breadths;

Consequently the velocities are reciprocally as the breadths.

VI. *In a running stream, the water above any obstacles put therein will rise to such a height, that by its fall the stream may be discharged as fast as it comes.*

For the same body of water, which flowed in the open chanel, must pass thro' the passages made by the obstacles:

And the narrower the passages, the swifter will be the velocity of the water:

But the swifter the velocity of the water, the greater is the height, from whence it has descended:

Consequently the obstacles, which contract the chanel, cause the water to rise against them.

But the rise will cease, when the water can run off as fast as it comes:

And this must happen, when, by the fall between the obstacles, the water will acquire a velocity in a reciprocal proportion to that in the open chanel as the breadth of the open chanel is to the breadth of the narrow passages.

VII. *The quantity of the fall caused by an obstacle in a running stream is measured by the difference between*

*tween the heights fallen from to acquire the velocities in the narrow passages and open chanel.*

For just above the fall, the velocity of the stream is such, as would be acquired by a body falling from a height higher than the surface of the water :

And at the fall, the velocity of the stream is such, as would be acquired by the fall of a body from a height more elevated than the top of the falling stream ; and consequently the real fall is less than this height.

Now as the stream comes to the fall with a velocity belonging to a fall above its surface ;

Consequently the height belonging to the velocity at the fall must be diminished by the height belonging to the velocity, with which the stream arrives at the fall.

#### PROBLEM.

*In a chanel of running water, whose breadth is contracted by one or more obstacles ; the breadth of the chanel, the mean velocity of the whole stream, and the breadth of the water-way between the obstacles being given ; To find the quantity of the fall occasioned by those obstacles.*

Let  $b$  = breadth of the chanel in feet.

$v$  = mean velocity of the water in feet per sec.

$c$  = breadth of the water-way between the obstacles.

Now  $25 : 21 :: c : \frac{21}{25} c$  the water-way contracted. . . . . Principle III.

And

And  $\frac{21}{25} c : b :: v : \frac{25b}{21c} v$  the veloc. *per* sec. in the water-way between the obstacles. . . *Princip.* V.

Also  $\overline{2a^2} : vv :: a : \frac{vv}{4a}$  the height fallen to acquire the vel. *v.* . . . I. & II.

And  $\overline{2a^2} : \left[ \frac{25b}{21c} \right]^2 \times vv :: a : \left[ \frac{25b}{21c} \right]^2 \times \frac{vv}{4a}$  the height fallen to acquire the vel.  $\frac{25b}{21c} v$ . . . I. & II.

Then  $\left[ \frac{25b}{21c} \right]^2 \times \frac{vv}{4a} - \frac{vv}{4a}$  is the measure of the fall required. . . VII.

Or  $\overline{\left[ \frac{25b}{21c} \right]^2} - 1 \times \frac{vv}{4a}$  is a rule, by which the fall may be readily computed.

Here  $a = 16,0899$  feet and  $4a = 64,3596$ .

#### EXAMPLE I. *For London-Bridge.*

By the observations made by Mr. Labelye in 1746, The breadth of the Thames at London-bridge is 926 feet;

The sum of the water-ways at the time of the greatest fall is 236 feet;

The mean velocity of the stream taken at its surface just above bridge is  $3\frac{1}{6}$  feet *per* second.

Under almost all the arches there are great numbers of drip-shot piles, or piles driven into the bed of the water-way, to prevent it from being washed away by the fall. These drip-shot piles considerably contract the water-ways, at least  $\frac{1}{6}$  of their measured breadth, or about  $39\frac{1}{2}$  feet in the whole.

So that the water-way will be reduced to 196 $\frac{5}{7}$  feet.

Now  $b = 926$ ;  $c = 196\frac{2}{3}$ ;  $v = 3\frac{1}{8}$ ;  $4a = 64,3596$ .

$$\text{Then } \frac{25b}{21c} = \frac{23150}{4130} = 5,60532$$

$$\text{And } \overline{5,60532}^2 = 31,4196; \text{ and } 31,4196 - 1 = 30,4196 = \frac{25b}{21c}^2 - 1.$$

$$\text{Also } vv = \frac{19}{6}^2 = \frac{361}{36}; \text{ And } \frac{vv}{4a} = \frac{361}{36 \times 64,3596} = 0,15581.$$

Then  $30,4196 \times 0,15581 = 4,739$  feet, the fall sought after.

By the most exact observations made about the year 1736, the measure of the fall was 4 feet 9 inches.

### EXAMPLE II. *For Westminster-Bridge.*

'Altho' the breadth of the river at Westminster-bridge is 1220 feet; yet, at the time of the greatest fall, there is water thro' only the thirteen large arches, which amount to 820 feet: to which adding the breadth of the twelve intermediate piers, equal to 174 feet, gives 994 for the breadth of the river at that time: and the velocity of the water just above bridge (from many experiments) is not greater than  $2\frac{1}{4}$  feet *per* second.

$$\text{Here } b = 994; c = 820; v = 2\frac{1}{4}; 4a = 64,3596.$$

$$\text{Now } \frac{25b}{21c} = \frac{24850}{17220} = 1,443.$$

And

$$\text{And } \overline{1,443}^2 = 2,082; \text{ And } 2,082 - 1 = 1,082$$

$$\frac{25 \cancel{b}^2}{21 \epsilon_1} - 1.$$

$$\text{Also } vv = \frac{9}{4}^2 = \frac{81}{16}; \text{ And } \frac{vv}{48} = \frac{81}{16 \times 64,3596} =$$

$$0,0786.$$

Then  $1,082 \times 0,0786 = 0,084$  feet, the fall fought.

Which is about 1 inch; and is about half an inch more than the greatest fall observed by Mr. Labelye.

**LXIV.** *An Account of the Earthquake in the West Parts of Cornwall, July 15th 1757. By the Rev. William Borlase, M. A. F. R. S. Communicated by the Rev. Charles Lyttelton, LL. D. Dean of Exeter, F. R. S.*

Read Jan. 26. 1758. **O**N Friday the 15th of July, 1757. a violent shock of an earthquake was felt in the western parts of Cornwall.

The thermometer had been higher than usual, and the weather hot, or calm, or both, for eight days before; wind east and north-east. On the 14th in the morning, the wind shifting to the south-west, the weather calm and hazy, there was a shower. The afternoon hazy and fair, wind north-west. The barometer moderately high, but the mercury remarkably variable.



On the 15th in the morning, the wind fresh at north-west, the atmosphere hazy. Being on the sands, half a mile east of Penzance, at 10 A.M. near low water, I perceived on the surface of the sands a very unusual inequality: for whereas there are seldom any unevennesses there, but what are made by the rippling of the water, I found the sands, for above 100 yards square, all full of little tubercles (each as large as a moderate mole-hill), and in the middle a black speck on the top, as if something had issued thence. Between these convexities were hollow basons of an equal diameter. From one of these hollows there issued a strong rush of water, about the bigness of a man's wrist, never observed there before nor since.

About a quarter after six, P.M. the sky dusky, the wind being at west north-west, it fell quite calm. At half past six, being then in the summer-house at Keneggy, the seat of the Hon. J. Harris, Esq; near Penzance, with some company, we were suddenly alarmed with a rumbling noise, as if a coach or waggon had passed near us over an uneven pavement; but the noise was as loud in the beginning and at the end, as in the middle; which neither the sound of thunder, or of carriages, ever is. The fast-casements jarred: one gentleman thought his chair moved under him; and the gardener, then in the dwelling house (about an hundred yards distant from us) felt the stone pavement of the room he was in move very sensibly.

In what place the shock began, and whether progressive or instantaneous in the several places where it was felt, is uncertain, for want of accurately determining the precise point of time in distant places.

The

The shock was not equally loud or violent. Its extent was from the isles of Scilly eastward as far as Liskerd, and towards the north as far as Camel-ford; thro' which district I shall trace it, according to the best informations I could procure.

In the island of St. Mary, Scilly, the shock was violent. On the shores of Cornwall, opposite to Scilly (in the parish of Senan, near the Land's-end) the noise was heard like that of a spinning-wheel on a chamber-floor. Below stairs there was a cry, that the house was shaking; and the brass pans and pewter rattled one against another in several houses in the same parish. In the adjoining parish of St. Just, two young men being then swimming, felt a strong and very unusual agitation of the sea. In the town of Penzance, in one house the chamber-bell rung; in another the pewter plates, placed edgeways on a shelf, shifted, and slid to one end of the shelf: and it was every-where perceived more or less, according as people's attention was engaged.

At Trevaile, the seat of William Veale, Esquire, about two miles from Penzance, the noise was heard, and thought at first to be thunder: the windows shook, and the walls of the parlour, where Mr. Veale sat, visibly moved. The jarring of the windows continued near half a minute; but the motion of the walls not quite so long: and some masons, being at work on a contiguous new building, the upright poles of the scaffolds shook so violently, that, for fear of falling, they laid hold on the walls, which, to their still greater surprize, they found agitated in the same manner. And a person present, who was at London at the time of the two shocks in  
the

the year 1751, thought this shock to resemble the second, both in degree and duration (1).

At Marazion, the next market-town east of Penzance, the houses of several persons shook to that degree, that people ran out into the street, lest the houses should fall upon them.

In the borough of St. Ives, on the north sea, six miles north of Penzance, the shock was so violent, that a gentleman, who had been at Lisbon during several shocks, said, that this exceeded all he had met with, except that on the 1st of November 1755, so fatal to that city.

At Tehidy, the seat of Francis Basset, Esq; the rooms shook, and the grounds without doors were observed to move. The shock was felt sensibly at Redruth, St. Columb, Bodman, &c. along to Camelford, which is about 90 miles from the isle of Scilly. From Marazion eastward it was felt at several places in like manner, as far as Lostwythel; but at Liskerd, about ten miles east of Lostwythel, it was but faintly perceived, and that by a few persons. It was still less sensible at Loo and Plymouth, "scarcely sufficient to excite curiosity or fear" (2).

The times of its duration were various. At Keneggy we thought the noise could not have lasted above six seconds; at Trevaier, not two miles distant to the west, it was thought to have lasted near half a minute; in the parish of Gwynier half a minute; at Ludgvan, three miles east of Penzance, the noise was rather longer than half a minute; but

(1) Letter from William Veale, Esq;

(2) Letter from John Trehawk, Esq;

the shaking felt in the garden, and observed in the houses, short and momentary. In Gernoe great Pinwork, seven miles east of Penzance, it lasted only a few seconds; but in the isles of Scilly it was computed at 40 seconds.

Thus was this earthquake felt in towns, houses, and grounds adjacent; but still more particularly alarming in our mines, where there is less refuge, and consequently a greater dread from the tremors of the earth.

In Carnorth adit, in the parish of St. Just, the shock was sensibly felt 18 fathom deep; in the mine called Boscadzhill-downs, more than 30 fathom.

At Huel-rith mine, in the parish of Lannant, people saw the earth move under them, first quick, then in a slower wavy tremor; and the stage-boards of the little winds or shafts 20 fathom deep were perceived to move.

In Herland mine, commonly called the Manor, in the parish of Gwynier, the noise was heard 55 and 60 fathom deep, as if a studdle (3) had broke, and the deads (4) were set a running. It was nothing like the noise of thunder.

In Chace-water mine the same noise was heard, at least 70 fathom under the surface.

At Huel-rith mine, near Godolphin, the noise was seemingly underneath. I felt (says the director of the mine) the earth move under me with a prodigious swift, and apparently horizontal tremor: its continuance was but for a few seconds of time,

(3) A timber support of the deads.

(4) Loose rubbish and broken stones of the mine.

not like thunder, but rather a dull rumbling even sound, like deads running under ground. In the smith's shop the window-leaves shook, and the flatting of the house cracked. The whim-house shook so terribly, that a man there at work ran out of it, concluding it to be falling. Several persons then in the mine, working 60 fathom deep, thought they found the earth about them to move, and heard an uncommon noise: some heard the noise, and felt no tremor; others, working in a mine adjoining called Huel-breag, were so frightened, that they called to their companions above to be drawn up from the bottoms. Their moor-house was shaken, and the padlock of their candle-chest was heard to strike against the staples. To shew, that this noise proceeded from below, and not from any concussion in the atmosphere above, this very intelligent captain of the mine (5) observes, from his own experience, that thunder was never known to affect the air at 60 fathoms deep, even in a single shaft pierced into the hardest stone; much less could it continue the sound thro' such workings as there are in this mine, impeded in all parts with deads, great quantities of timber, various noises, such as the rattling of chains, friction of wheels and ropes, and dashing of waters; all which must contribute to break the vibrations of the air as they descend: and I intirely agree with this gentleman's conclusion, that thunder, or any other noises from above in the atmosphere, could not be heard at half the depth of this mine. This therefore could be no other than a real tremor of the earth,

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(5) Mr. J. Nantcarrow.

attended with a noise, owing to a current of air and vapour proceeding upwards from the earth.

I do not hear of any person in those parts, who was so fortunate as to be near any pool or lake, and had recollection enough to attend to the motion of the waters ; but it may be taken for granted, that during the tremors of the earth the fluids must be more affected than the solids : nay, the waters will apparently be agitated, when there is no motion of the earth perceptible, as was the case of our ponds and lake-waters in most parts of Britain on the 1st of November 1755. Whence this happens is difficult to say : whether the earth's bosom undergoes at such times a kind of respiration, and alternately emits and withdraws a vapour thro' its most porous parts sufficient to agitate the waters, yet not sufficient to shake the earth ; or whether the earth, during the agitation of the waters, does rock and vacillate, tho' not so as to be sensible to man ; is what I shall leave to future inquiry.

Earthquakes are very rare in Cornwall. This was but of short duration, and did no harm any-where, as far as I can learn ; and it is to be hoped not the sooner forgotten for that reason ; but rather remembered with all the impressions of gratitude suitable to an incident so alarming and dangerous, and yet so inoffensive.

LXV. *Some Observations upon the Sleep of Plants; and an Account of that Faculty, which Linnæus calls Vigilæ Florum; with an Enumeration of several Plants, which are subject to that Law. Communicated to Wm. Watson, M.D. F.R.S. by Mr. Richard Pultney of Leicester.*

Read Jan. 26.  
1758.

**A** Costa and Prosper Alpinus, who both wrote near the conclusion of the XVIth century, are, I believe, the first, who recorded that nocturnal change in the leaves of plants, which has since been called *sonnus*. It is an observation indeed as old as Pliny's time, that the leaves of trefoil assume an erect situation (1) upon the coming of storms. The same is observable of our wood-forrel; and Linnæus adds, of almost all plants with declined stamina (2). In the *Trifolium pratense album* C. B. or common white-flowered meadow trefoil, it is so obvious, that the common people in Sweden remark, and prognosticate the coming of tempests and rain from it.

The examples of sleeping plants instanced by Alpinus are but few. That author says, it was common to several Egyptian species (3); but specifies only the *Acaciæ*, *Abrus*, *Abfus*, *Sesban*, and the *Tamarind-*

(1) *Trifolium quoque inhorrescere et folia contra tempestatem subrigere certum est. Hist. Nat. lib. xviii. cap. 35.*

(2) *Flor. Lappon. p. 222.*

(3) *Prosp. Alpin. de plantis Ægypti, cap. 10.*

tree. Cornutus some time afterwards remarked this property in the *Pseudo-acacia Americana*. From that time it has remained almost unnoticed, till Linnæus, ever attentive to nature's works, discovered that the same affair was transacted in many other plants; and his observations have furnished us with numerous and obvious examples thereof. Mr. Miller mentions it in the *Medicago arborea* Lin. *Sp. Pl.* 778. and we may add to the list two other common plants not mentioned by Linnæus: these are the *Phaseolus vulgaris*, common kidney-bean; and the *Trifolium pratense purpureum majus*, or clover-grass: in both which this nocturnal change is remarkably displayed. Doubtless the same property exists in numberless other species; and future observation will very probably confirm Dr. Hill's sentiment, that no "plant or tree" is wholly unaffected by it."

It is now more than twenty years since Linnæus first attended to this quality in plants. In his *Flora Lapponica*, when speaking of the *Trifolium pratense album*, as above-mentioned, he remarks, that the leaves of the Mimosa, Cassia, Bauhinia, Parkinsonia, Guilandina, and others in affinity with them, were subject to this change in the night time: and he had then carried his observations so far, as to find, that heat and cold were not the cause of this quality; since they were alike influenced by it when placed in stoves, where the temperature of the air was always the same.

The merit of reviving this subject is therefore due to the illustrious Swede; and the naturalist is greatly indebted to him for so far extending his observations thereon.



The subject of the *somnus plantarum* cannot but be highly entertaining to the lovers of natural knowledge: and such, I apprehend, cannot be less entertained with that faculty, which Linnæus calls *vigiliae florum*; of which we shall give a brief account.

Previous to our explanation of this affair it is proper to observe, that the flowers of most plants, after they are once opened, continue so night and day, until they drop off, or die away. Several others, which shut in the night-time, open in the morning either sooner or later, according to their respective situation in the sun or shade, or as they are influenced by the manifest changes of the atmosphere. There are however another class of flowers, which make the subject of these observations, which observe a more constant and uniform law in this particular. These open and shut duly and constantly at certain and determinate hours, exclusive of any manifest changes in the atmosphere; and this with so little variation in point of time, as to render the phenomenon well worth the observation of all, whose taste leads them this way.

This faculty in the flowers of plants is not altogether a new discovery; but we are indebted to the same hand for additional observations upon this head likewise. It is so manifest in one of our common English plants, the *Tragopogon luteum*, that our country people long since called it *John-go-to-bed-at-noon*. Linnæus's observations have extended to near fifty species, which are subject to this law. What we find principally upon this subject is in the *Philosophia Botanica*, p. 273. We will enumerate these plants, and mention the time when the flowers open and shut,

shut, that those, who have opportunity and inclination, may gratify themselves, and probably at the same time extend this branch of botanic knowledge still farther.

It is proper to observe, that as these observations were made by Linnæus in the academical garden at Upsal, whoever repeats them in this country will very probably find, that the difference of climate will occasion a variation in point of time: at least this will obtain in some species, as our own observations have taught us; in others the time has corresponded very exactly with the account he has given us.

Whether this faculty hath any connexion with the great article of fecundation in the oeconomy of flowers, I cannot determine: in the mean time it is not improbable. Future and repeated observations, and well-adapted experiments, will tend to illustrate this matter, and it may be lead the way to a full explanation of the cause.

1. *Anagallis flore phœniceo* C. B. pin. 252. Raii Syn. p. 282. *Anagallis arvensis* Lin. Spec. plant. p. 148. *The Male Pimpernel*. The flowers of this plant open about eight o'clock in the morning, and never close till past noon. This plant is common in kitchen-gardens and in corn-fields, and flowers in June, and continues in flower three months.

2. The *Anagallis cærulea foliis binis ternisve ex adverso nascentibus* C. B. pin. p. 252. Raii Hist. Plant. p. 1024. *Anagallis Monelli* Sp. plant. 148. *Blue-flowered Pimpernel with narrow leaves*. The flowers of this plant observe nearly the same time in opening and shutting as the foregoing.

3. *Convolvulus peregrinus cæruleus folio oblongo* C. B. pin. 295. *Convolvulus tricolor* Sp. plant. 158. *Little blue Convolvulus, or Bindweed.* This opens its flowers between the hours of five and six in the morning, and shuts them in the afternoon.

4. *Phalangium parvo flore ramosum* C. B. pin. 29. Raii Hist. Pl. 1193. *Branched Spiderwort with a small flower.* These open about seven in the morning, and close between the hours of three and four in the afternoon.

5. *Lilium rubrum Asphodeli radice* C. B. pin. 80. *Hemerocallis fulvus* Sp. pl. 324. *The Day Lily.* The flowers open about five in the morning, and shut at seven or eight in the evening

6. *Plantago aquatica minor.* Park. 1245. Raii Syn. 257. *Alisma ranunculoides* Sp. pl. 343. Fl. Suec. 2. N<sup>o</sup>. 325. *The lesser Water-Plantain,* during its flowering-time, only opens its flowers each day about noon.

7. *Caryophyllus sylvestris prolifer* C. B. pin. 209. Raii Syn. 337. *Dianthus prolifer* Sp. pl. 410. *Proliferous Pink.* The flowers expand about eight in the morning, and close again about one in the afternoon.

8. *Spergula purpurea* J. B. III. 722. Raii Syn. p. 351. *Arenaria rubra.* Sp. pl. 423. *Pur le Spurrey.* These expand between nine and ten in the morning, and close between two and three in the afternoon. This little plant is common among the corn in sandy soils, and flowers in June.

9. *Portulaca latifolia sativa* C. B. pin. 288. *Portulaca oleracea* Sp. pl. p. 445. *Common Purslain,* opens its flowers about nine or ten in the morning, and closes them again in about an hour's time.

10. *Ficoides Africana*, folio plantaginis undulato micis argenteis adsperso Boerh. Ludg. I. p. 291. *Mesembryanthemum chrySTALLINUM* Sp. pl. 480. *Diamond Ficoides*. The flowers of this plant open at nine or ten, and close at three or four in the afternoon.

11. *Ficoides Africana* folio tereti in villos radiatos abeunte. Tourn. *Mesembryanthemum barbatum* Sp. pl. 482. The flowers of this species expand at seven or eight in the morning, and close about two in the afternoon.

12. *Ficoides* folio tereti Neapolitana flore candido Herm. Ludg. 252. *Kali Crassulæ minoris foliis* C. B. pin. 289. *Mesembryanthemum nodiflorum* Sp. pl. 480. The flowers of this plant open at ten or eleven in the morning, and close at three in the afternoon.

13. *Mesembryanthemum folio linguiformi latiore* Dillen. Hort. Elth. *Mesembryanthemum linguiforme* Sp. pl. 488. *Ficoides with a tongue-shaped leaf*. These open at seven or eight in the morning, and are closed about three in the afternoon.

14. *Nymphæa alba* J. B. III. 770. Raii Syn. 368. *Nymphæa alba* Sp. pl. 510. Fl. Suec. 2. N°. 470. *White Water Lily*. This plant grows in rivers, ponds, and ditches, and the flowers lie upon the surface of the water. At their time of expansion, which is about seven in the morning, the stalk is erected, and the flower more elevated above the surface. In this situation it continues till about four in the afternoon, when the flower sinks to the surface of the water, and closes again.

15. *Papaver erraticum nudicaule flore flavo odorato* Dillen. Hort. Elth. 302. *Papaver nudicaule* Sp. pl.

pl. p. 507. *Wild Poppy with a naked stalk and a yellow sweet-smelling flower.* The flower of this plant opens at five in the morning, and closes at seven in the evening.

16. *Alyffoides incanum*, foliis sinuatis Tourn. Inst. 213. *Alyffium sinuatum* Sp. pl. 651. *Hoary Madwort with sinuated leaves.* The flowers of this plant expand between the hours of six and eight in the morning, and close at four in the afternoon.

17. *Abutilon repens alceæ foliis*, flore helvolo Dillen. Hort. Elth. 5. *Malva Caroliniana* Sp. pl. 688. *Creeping Indian Mallow with leaves like Vervain Mallow, and a flesh-coloured flower.* These open at nine or ten in the morning, and close at one in the afternoon.

18. *Tragopogon luteum* Ger. 595. Raii Syn. 171. *Tragopogon pratense* Sp. pl. 789. *Yellow Goats Beard*, or *Go-to-bed-at-noon.* The latter of these names was given to this plant long since, on account of this remarkable property. The flowers open in general about three or four o'clock, and close again about nine or ten, in the morning. These flowers will perform their *vigiliæ*, if set in a phial of water, within doors for several mornings successively; and I have sometimes observed them to be quite closed, from their utmost state of expansion, in less than a quarter of an hour. It flowers in June.

19. *Tragopogon gramineis foliis*, hirsutis. C. B. pin. 275. Raii. Hist. Plant. 253. *Rose-coloured Goats Beard.* These open between five and six in the morning, and close about eleven. *Tragopog. hybridum* Sp. plant. 789.

20. *Tragopogon*, calycibus corolla brevioribus inermibus,

ermibus, foliis lyrato-sinuatis. Hort. Upf. 244. Sp. pl. 790. Hall. Hort. Gotting. 2. p. 419. The flowers of this plant open at six or seven in the morning, and shut between the hours of twelve and four in the afternoon.

21. *Sonchus Tingitanus papaveris folio*. Tourn. Raii Suppl. 137. *Scorzonera Tingitana* Sp. pl. 791. *African Sowthistle with a poppy leaf*. This plant opens its flowers between four and six in the morning, and closes them in about three hours.

22. *Sonchus repens, multis hieracium majus* J. B. II. 1017. Raii Syn. 163. *Sonchus arvensis* Sp. pl. 793. *Tree Sowthistle*. These flowers expand about six or seven, and close between eleven and twelve in the forenoon. This is common in corn-fields, and flowers in June, July, and August.

23. *Sonchus lævis* Ger. Raii Syn. 162. *Sonchus oleraceus* Sp. pl. 794. *Smooth or unprickly Sowthistle, Hares Lettuce*. These open about five in the morning, and close again at eleven or twelve.

24. *Sonchus lævis laciniatus cæruleus* C. B. pin. 124. Raii Hist. pl. 225. *Sonchus alpinus* Sp. pl. 794. *Blue-flowered Mountain Sowthistle*. These open about seven, and close about noon.

25. *Sonchus tricubitalis, folio cuspidato* Merr. pin. Raii Syn. 163. *Sonchus asper arborescens* C. B. pin. 124. *Sonchus palustris* Sp. pl. 793. *The greatest Marsh-tree Sowthistle*. It expands its flowers about six or seven, and closes them about two in the afternoon.

26. *Lactuca fativa* C. B. pin. 122. Sp. pl. 795. *Garden Lettuce*, opens its flowers about seven, and closes them about ten, in the forenoon.

27. *Dens leonis* Ger. 228. Raii Syn. 170. *Leontodon Taraxacum* Sp. pl. 798. *Dandelion*. It expands at five or six, and closes at eight or nine, in the forenoon. This flowers early in the spring, and again in the autumn.

28. *Dens leonis hirsutus leptocaulos*, *Hieracium dictus*. Raii Syn. 171. *Leontodon hispidum* Sp. pl. 799. *Rough Dandelion*, or *Dandelion Hawkweed*. This plant opens its flower about four in the morning, and keeps it expanded till three in the afternoon. In May.

29. *Hieracium minus præmorsa radice*. Park. 794. Raii Syn. 164. *Leontodon autumnale*. Sp. pl. 799. *Hawkweed with bitten roots*, or *Yellow Devil's-bit*. The flowers open about seven, and keep in an expanded state till about three in the afternoon. It flowers in July and August.

30. *Pilosella repens* Ger. 573. Raii Syn. 170. *Hieracium Pilosella* Sp. pl. 800. *Common creeping Mouse-ear*. It opens about eight in the morning, and closes about two in the afternoon. Very common on dry pastures, flowering in June and July.

31. *Hieracium murorum folio pilosissimo* C. B. pin. 129. Raii Syn. 168. *Hieracium murorum* Sp. pl. 802. The flowers of this plant expand about six or seven, and close about two in the afternoon. Upon old walls, flowering in June and July. This is called in English, *French* or *Golden Lungwort*.

32. *Hieracium fruticosum angustifolium majus*. C. B. pin. 129. *Hieracium umbellatum* Sp. pl. 804. *Narrow-leaved bushy Hawkweed*. The flowers of this species expand about six in the morning, and remain open till five in the afternoon.

33. *Hiera-*

33. *Hieracium fruticosum latifolium hirsutum* C. B. pin. 129. Raii Syn. p. 167. *Hieracium sabaudum* Sp. pl. 804. *Bushy Hawkweed with broad rough leaves.* These flowers are in their expanded state from about seven in the morning till one or two in the afternoon. In woods, flowering in June and July.

34. *Hieracium montanum cichorii folio.* Raii. Syn. p. 166. *Hieracium paludosum* Sp. pl. 638. Fl. Suec. 2. N<sup>o</sup>. 702. *Succory-leaved Mountain Hawkweed.* The flowers expand about six in the morning, and close about five in the afternoon.

35. *Hieracium hortense floribus atro-purpurascen-  
tibus* C. B. pin. 128. *Hieracium aurantiacum* Sp. pl. 801. *Garden Hawkweed with deep purple flowers,  
or Sweet Indian Mouse-ear.* The flowers are in their expanded state from six or seven in the morning till three or four in the afternoon.

36. *Hieracium luteum glabrum, five minus hirsutum.* J. B. Raii Syn. 165. *Crepis tectorum* Sp. pl. 807. *Smooth Succory Hawkweed.* The flowers of this plant expand about four in the morning, and close about noon.

37. *Hieracium Alpinum Scorzonæræ folio* Tourn. Inf. 472. *Crepis Alpina* Sp. pl. 806. *Mountain Hawkweed with a vipers-grass leaf.* These open about five or six, and close at eleven in the forenoon.

38. *Hieracium dentis leonis folio, flore suave-  
bente,* C. B. pin. 127. Raii hist. pl. 231. *Crepis ru-  
bra* Sp. pl. 806. *Hawkweed of Apulia with a flesh-  
coloured flower.* The flowers remain in their ex-  
panded state from six or seven in the morning till  
one or two in the afternoon.



39. *Hieracium echinoides*, capitulis cardui benedicti C. B. pin. 128. Raii Syn. 166. *Picris echinoides* Sp. pl. 792. *Lang de bæuf*. On banks about hedges, and about the borders of fields, flowering in August. These expand about four or five in the morning, and never close before noon: sometimes they remain open till nine at night.

40. *Hieracium Alpinum latifolium hirsutæ incanum flore magno*. C. B. pin. 128. Raii Syn. p. 167. *Hypochaeris maculata* Sp. pl. 810. *Broad-leaved Hungarian Hawkweed*. These flowers are in their vigilating state from six in the morning till four in the afternoon.

41. *Hieracium ramosum, floribus amplis, calycibus valde hirsutis, foliis oblongis obtusis: dentibus majoribus inæqualibus incisfis* Raii Suppl. 144. 76. *Hypochaeris Achyrophorus* Sp. pl. 810. This plant opens its flowers about seven or eight in the morning, and closes them about two in the afternoon.

42. *Hieracium minus dentis leonis folio, oblongo glabro* C. B. pin. 127. *Hypochaeris glabra* Sp. pl. 811. These expand about nine in the morning, and close about twelve or one o'clock.

43. *Hieracium falcatum alterum* Raii Hist. 256. *Lapsana calycibus fructus undique patentibus, radiis subulatis, foliis lyratis* Hort. Upsl. 245. Sp. pl. 812. The flowers open at five or six, and close between the hours of ten and one.

44. *Hedypnois annua* Tourn. Inst. 478. *Hyoseris hedypnois* Sp. pl. 809. The flowers open at seven or eight, and close again at two in the afternoon.

45. *Hieracium montanum alterum leptomacraulon* Col. Raii Hist. 234. *Lapsana chondrilloides* Sp.

Sp. pl. 812. *Mountain Hawkweed with long slender stalks and small flowers.* The flowers are in their expanded or vigilating state from five or six in the morning till about ten.

46. *Cichoreum sylvestre* Ger. em. 284. Raii Syn. 172. *Cichorium Intybus* Sp. pl. 813. *Wild Succory.* On the borders of fields, flowering in August and September. The flowers open about eight in the forenoon, and keep expanded till about four in the afternoon.

47. *Calendula arvensis* C. B. pin. 275. Raii Hist. 338. *Calendula officinalis* Sp. pl. 921. *Wild Marigold.* The flowers expand from nine in the morning till three in the afternoon.

48. *Calendula foliis dentatis* Roy. Ludg. 177. Miller, p. 50. Tab. 75. f. 1. *Calendula pluvialis* Sp. pl. 921. *Marigold with indented leaves.* The flowers expand from seven in the morning till three or four in the afternoon. Linnæus observes of this plant, that if its flowers do not expand about their usual time in the morning, it will almost assuredly rain that day; with this restriction indeed, that the plant is not affected by thunder showers. Phil. Bot. 275.

49. *Sonchus pedunculis squamatis, foliis lanceolatis indivisis sessilibus.* Hort. Upsal. 244. Flor. Suec. 2. N°. 690. *Lactuca Salicis folio, flore cæruleo.* Amman. ruth. 211. Of this plant it is remarked, that whenever the flowers are in the expanded state in the night-time, the following day generally proves rainy.

LXVI. *An Account of the Case of a Boy troubled with convulsive Fits cured by the Discharge of Worms. By the Rev. Richard Oram, M. A. Chaplain to the Lord Bishop of Ely.*

Read Jan. 26, 1758. **J**oseph, son of John and Mary Postle, of Ingham in the county of Norfolk, was subject to convulsive fits from his infancy; which were common and tolerable till he was about seven years of age. About that time they began to attack him in all the varieties that can be conceived. Sometimes he was thrown upon the ground; sometimes he was twirled round like a top by them; at others he would spring upwards to a considerable height, &c. and once he leaped over an iron bar, that was placed purposely before the fire to prevent his falling into it. He was much burned; but was rendered so habitually stupid by his fits, that he never expressed the least sense of pain after this accident. His intellect was so much impaired, and almost destroyed, by the frequency and violence of his fits, that he scarce seemed to be conscious of any thing. He did not acknowledge his father or mother by any expressions or signs; nor seemed to distinguish them from other people. If at any time he escaped out of the house without the observation of the family, he had not understanding to find and return to it; but would pursue the direction or road he first took, and sometimes lose himself. Once he was missing for a whole night; and found the next morning

morning in the middle of a fen, stuck fast in mud as deep as his breast. He was very voracious, and would frequently call for something to eat ; which was the only indication he gave of his knowing any thing. No kind of filth or nastiness can be conceived, which he would not eat or drink without distinction. He appeared to be as ill as he really was ; for he was become a most shocking spectacle. He was so much emaciated, that he seemed to have no flesh upon his bones ; and his body so distorted, that he was rendered quite a cripple. His parents consulted a physician at Norwich, who very judiciously (as it will appear) considered his disorder as a worm-case, and prescribed for it accordingly ; but (being afraid, I presume, to give too violent medicines to the boy) without success. In short, he was so singularly afflicted, that his parents told me they could not help thinking him under some evil influence.

It was observed, that his disorder varied, and grew worse, at certain periods of the moon.

In these miserable circumstances the poor boy continued to languish, till he was about eleven years of age (July 1757), when he accidentally found a mixture of white lead \* and oil, which had some time before been prepared for some purpose of painting, set by on a shelf, and placed, as it was thought, out of his reach. There was near half a pint of this mixture when he found it ; and, as he did not leave

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\* It is not improbable, that a considerable portion of whiting might be used instead of pure white lead, which is frequently done : and this supposition is favoured by the mixture's not proving fatal to the boy, as such a quantity of white lead in all probability would.

much, it is thought he swallowed about a quarter of a pint of it. There was also some lamp-black in the composition ; which was added to give it a proper colour for the particular use it was intended for in painting. It was, as I suppose it usually is linseed oil, which had been mixed with the lead and lamp-black.

The draught began to operate very soon, by vomiting and purging him for near 24 hours in the most violent manner. A large quantity of black inky matter was discharged ; and an infinite number of worms, almost as small as threads, were voided. These operations were so intense, that his life was despaired of. But he has not only survived them, but experienced a most wonderful change and improvement after them : for his parents assured me in November 1757, when I saw him, that he had daily grown better from the time of his drinking the mixture, both in body and mind. Instead of a skeleton, as he almost was before, he is become fat, and rather corpulent : and his appetite is no longer ravenous, but moderate and common. His body too is become straight and erect. His understanding is at least as much benefited by this peculiar remedy. It cannot be expected, that he should already have attained much knowledge, as he seemed, before he was so wonderfully relieved, to be almost destitute of ideas. But he appeared, when I saw him, to have acquired nearly as much knowledge in four months, as children usually do in four years ; and to reason pretty well on those things, which he knew. He is now capable of being employed on many occasions ; is often sent a mile or two on errands, which he discharges

charges as carefully, and then returns as safely, as any person.

It is farther remarkable, that the boy's mother, her father, and sister, are frequently infested with worms. Her father, tho' about 60 years of age, is still much troubled with them: the worms, which he voids, appear flat, and much larger than those, which his children have observed. Her sister is often exceedingly disordered by them. About three months since they threw her into violent convulsions, and for some time deprived her of her senses. But the mother of the boy has been affected in a more extraordinary manner than the rest. About 20 years ago she voided some worms, which forced their way thro' the pores of the skin, as it is supposed; for they were found in small clusters under her arms. As she was very young then, she does not remember how she was particularly affected; only, that she suffered violent struggles and convulsions. She is still, about five or six times in a year, seized with fainting fits, which usually attack her in bed, and last three or four minutes; but she cannot certainly say, tho' there is very little reason to doubt, that they are occasioned by worms.

*An Account of the same Subject, in a Letter from Mr. John Gaze, of Walket, in the County of Norfolk, to Mr. Wm. Arderon, F. R. S. Communicated by Mr. Henry Baker, F. R. S.*

Read Jan. 26. 1758. **J**oseph Postle, son of John Postle, of Ingham in Norfolk, until about the age of seven years was an healthy well-looking child;  
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child; but about that age was afflicted with stoppages, which often threw him into convulsive fits, and at last rendered him quite an idiot. He continued in this condition for about four years, eating and drinking all that time any thing that came in his way, even his own excrements, if not narrowly watched. His father took the advice of several eminent physicians, both at Norwich and elsewhere; but all their prescriptions proved of no service.

About the beginning of August last he happened to get at a painting-pot, wherein there was about a pound of white lead and lamp-black mixed up with linseed oil. This he eat almost all up before he was discovered. It vomited and purged him, and brought away prodigious numbers of small worms. In a few days he grew well, his senses returned, and he is now able to give as rational answers as can be expected from a boy of his age. His appetite is good, he is very brisk, and has not had the least return of his former disorder.

I heard of the above by several people; but not being satisfied, got my friend to go to Mr. Postle's house, of whom he had the foregoing account.

January 12th, 1758.

LXVII. *An Account of the extraordinary Heat of the Weather in July 1757, and of the Effects of it. In a Letter from John Huxham, M. D. F. R. S. to Wm. Watson, M. D. F. R. S.*

Read Feb. 2, 1758. **I** Find by your letter, that the heat at London was not so great in the beginning of July 1757, as at Plymouth by two or three degrees of Fahrenheit's thermometer. We had again, after much rain at the close of the month, and in the beginning of August, excessive heat; *viz.* on the 8th, 9th, and 10th of August; which mounted the mercury in that thermometer to 85; nay, on the 9th, to near 86. I never before remember the mercury in that thermometer to exceed 84; and that is even here a very extraordinary degree of heat.

The consequences of this extremely hot season were hæmorrhages from several parts of the body; the nose especially in men and children, and the uterus in women. Sudden and violent pains of the head, and vertigo, profuse sweats, great debility and oppression of the spirits, affected many. There were putrid fevers in great abundance; and a vast quantity of fluxes of the belly both bilious and bloody, with which the fevers also were commonly attended. These fevers were always ushered in by severe pains of the head, back, and stomach; vomitings of green and sometimes of black bile, with vast oppression of the *præcordia*, continual anxiety, and



want of sleep. These were soon succeeded by *tremores tendinum*, *subsultus*, delirium, or stupor. The pulse was commonly very quick, but seldom tense or strong; was sometimes heavy and undose. The blood oftentimes florid, but loose; sometimes livid, very rarely fizy: in some however, at the very attack, it was pretty dense and florid. The tongue was generally foul, brown, and sometimes blackish; and towards the crisis often dry. The urine was commonly high coloured, and in small quantity; frequently turbid, and towards the end deposited a great deal of lateritious sediment. A vast number were seized with this fever, during, and soon after, the excessive heats; tho' but few died in proportion. Long and great heats always very much exalt the acrimony of the bilious humours; of which we had this summer abundant instances.

Bleeding early was generally beneficial; profuse, always hurtful, especially near the state of the fever.

LXVIII. *An Account of the fossile Thigh-bone of a large Animal, dug up at Stonesfield, near Woodstock, in Oxfordshire. In a Letter to Mr. Peter Collinson, F. R. S. from Mr. Joshua Platt.*

Dear Sir,

Read Feb. 2.  
1758.

**A**BOUT three years ago I sent you some *vertebrae* of an enormous size, which were found in the slate-stone pit at Stonesfield, near Woodstock, in this county.

I have



1 2 4 6 8 10 12 14



*Philos. Trans. Vol. L. TAB. XIX. p. 525.*





I have lately been so lucky as to procure from the same place the thigh-bone of a large animal, which probably belonged to the same creature, or one of the same genus, with the *vertebræ* above-mentioned.

As the bone, and the stone, in which it is bedded, weigh no less than two hundred pounds, I have sent you a drawing of it (*See TAB. XIX.*); from which, and the following short description, you may, I hope, form some idea of this wonderful fossil.

The bone is 29 inches in length; its diameter, at the extremity of the two trochanters, is 8 inches; at the lower extremity the condyles form a surface of 6 inches. The lesser trochanter is so well expressed in the drawing, that you cannot mistake it; and both the extremities appear to be a little rubbed by the fluctuating water, in which I apprehend it lay some time before the great jumble obtained, which brought it to this place; and from whence I imagine it to have been part of a skeleton before the flood. For if it had been corroded by any menstruum in the earth, or during the great conflux of water before the draining of the earth, it must have suffered in other parts as well as at each end: but as the extremities only are injured, we can attribute such a partial effect to the motion of the water only, which caused it to rub and strike against the sand, &c.

The small trochanter was broken in lifting it out of the hamper, in which it was brought to me; but not unhappily; since all the *cancelli* were by that means discovered to be filled with a sparry matter, that fixed the stone of the stratum, in which it lay. The outward coat or cortex is smooth, and of a dusky

dusky brown colour, resembling that of the stone, in which it is bedded.

One half of the bone is buried in the stone; yet enough of it is exposed to shew, that it is the thigh-bone of an animal of greater bulk than the largest ox. I have compared it with the recent thigh-bone of an elephant; but could observe little or no resemblance between them. If I may be allowed to assume the liberty, in which fossilists are often indulged, and to hazard a vague conjecture of my own, I would say it may probably have belonged to the hippopotamus, to the rhinoceros, or some such large animal, of whose anatomy we have not yet a competent knowledge.

The slate-pit, in which this bone was found, is about a quarter of a mile north-west from Stonesfield, upon the declivity of a rising ground, the upper stratum of which is a vegetable mould about eight or ten inches thick: under this is a bed of rubble, with a mixture of sand and clay, very coarse, about six feet deep, in which are a great number of *anomia* both plain and striated, and many small oblong oysters, which the workmen call the sickle-oyster, some of them being found crooked, and bearing some resemblance to that instrument; but all differing from the *curvi-rostra* \* of Moreton.

Immediately under this stratum of rubble is a bed of soft grey stone, of no use; but containing the *echini ovarii*, with great *mamillæ*, the *clypeati* of different sizes, all well preserved; and also many *anomia* and *pectines*. This bed, which is about se-

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\* What Lhwyd calls *ostreum minus falcatum*, N<sup>o</sup>. 451.

ven or eight feet in depth, lies immediately above the stratum of stone, in which the bone was found.

This stratum is never wrought by the workmen, being arenarious, and too soft for their use. It is about four or five feet thick, and forms a kind of roof to them, as they dig out the stone, of which the slates are formed; for they work these pits in the same manner as they do the coal-pits, leaving pillars at proper distances to keep their roof from falling in.

This last bed of slate-stone is about five feet depth, and lower than this they never dig. So that the whole depth of the pit amounts to about 24 or 25 feet.

It was by working out the slate-stone, that this bone was discovered sticking to the roof of the pit, where the men were pursuing their work; and with a great deal of caution, and no less pains, they got it down intire, but attached to a large piece of stone; and in this state it now remains in my possession.

There is no water in the works, but such as descends from the surface thro' perpendicular fissures; and the whole is spent in forming the stalactites and stalagmites, of which there is great variety, and whose dimensions are constantly increasing. One of the workmen has been so curious, as to mark the time of the growth of some of them for several years past.

I am, with the greatest esteem,

Dear Sir,

Your ever obedient,

and most humble Servant,

Oxon,  
Jan. 20. 1758.

Joshua Platt.



**LXIX.** *A Discourse on the Usefulness of Inoculation of the horned Cattle to prevent the contagious Distemper among them. In a Letter to the Right Hon. George Earl of Macclesfield, P. R. S. from Daniel Peter Layard, M. D. F. R. S.*

My Lord,

Read Feb. 2.  
1758.

**T**HE honour you have done me, in condescending to peruse my Essay on the contagious Distemper among the horned Cattle, claims my most respectful thanks; and I am no less obliged to your Lordship for the just remark you made, "That before inoculation could be practised on the horned Cattle, it is necessary to bring proofs, that this disease is not susceptible more than once; and also assurances, that a recovery from the distemper by inoculation guards the beast from a second infection."

An intire conviction of the analogy between this disease and the small-pox would not permit me to omit mentioning the great advantages, which must arise from inoculation; and therefore, my Lord, I recommend its use: nor do I find any reason to alter my opinion, after having carefully read over what has been published, and made the strictest inquiry I was able in several parts of Great Britain.

I shall, in the concise manner possible, submit the following particulars to your Lordship's consideration, and the learned Society, over which you so deservedly preside.

The

The Marquis de Courtivron, in two memoirs read before the Royal Academy of Sciences in the year 1748, and published by that learned body, relates the observations he, together with Monsieur Pelverfier de Gombeau, formerly surgeon to the regiment de la Sarre, made on the rise, progress, and fatality, of the contagious distemper at Issurtille, a town in Burgundy; to which are added experiments they made, by application, digestion, and inoculation, towards communicating the disease; and concludes from the failure of these attempts, that the distemper can only be communicated from one beast to another. Besides, notwithstanding the Marquis observes (1) the regularity of the illness, the critical days, on the seventh and ninth, and particularly that all such as recovered had more or fewer pustules broke out in different parts of the body; yet (2) he will not allow of Rammazzini's opinion, of the analogy between this distemper and the small-pox, nor that it is an eruptive fever; but ranks it as a plague.

But the Marquis goes still farther. He positively say, (3) "That in the preceding years, in the provinces of Bresse, Maconnois, and Bugey, some private persons had suffered by buying cattle recovered from the distemper, which had, at that time, the pustules remaining on them: which cattle had the distemper afterwards." Nay, he adds that "even after recovering twice, a third infection has seized and killed many."

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(1) *Memoires de l'Acad. des Sciences*, anno 1748. p. 326.

(2) *Ibid.* p. 338.

(3) *Ibid.* p. 337.

No wonder, my Lord, that such positive assertions should stagger, and cause the practice of inoculation not to be received, till the nature of the disease be absolutely determined, and facts prove the contrary of what has been asserted.

In a matter of so great importance to every nation, it were to be wished, that the Marquis de Courtivron had produced attested observations of these second and third infections: for tho' a nobleman of his rank, character, and great abilities, would not willingly impose upon the world; yet it may happen, that he may have received wrong informations.

As to the nature, rise, progress, and fatality, of this distemper at Iffurtille, it appears to be the same disease as raged in these kingdoms. All the symptoms agree, as described by Rammazzini, Lancisi, the Marquis, and in my Essay. A distempered beast gave rise to the three infections. The illness was every-where the same in Italy, France, and Britain; and either terminated *fatally* on the fourth or fifth day, when a scouring prevented the salutary eruptions, or in some cases by abortion; and on the seventh or ninth *favourably*, when the pustules had regularly taken their course. Tho' the Marquis did not observe, that any particular medicines were of use, he says, that in general acids were beneficial, especially poor thin wines somewhat four; and that the distempered beasts were all fond of these acids (4).

The fatality was likewise the same, as will appear from the Marquis's tables. Of 192 head of cattle, 176 died. The mortality was chiefly among the fat

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(4) See my Essay on the contagious Distemper, p. 70.

cattle,

cattle, cows with calf, and young sucking or yearling calves ; and of the surviving sixteen, only two calves out of seventy-seven lived, and these two, with seven other beasts of the sixteen, escaped the infection, tho' constantly among the diseased : so that it is plain,

Of 192 beasts, - - 176 died
7 recovered
9 escaped the infection.
<hr style="width: 10%; margin: 0 auto;"/>
192

The mortality was as considerable in these kingdoms.

Whoever will compare the appearances, progress, and fatality, of the small-pox, with what is remarked by authors of authority, as Rammazzini and Lancisi, and other observers, relative to the contagious distemper among the horned cattle, will not be at a loss one moment to determine, whether this disease be an eruptive fever, like unto the small-pox, or not.

Now if, as the Marquis has granted in both his memoirs (5), it be a general observation, that an eruption of pustules on some parts of the body, regularly thrown out, digested, and dried, is the means used by nature to effect the cure ; and that in general the morbid matter does not affect the parotid, inguinal, or other glands, nor produce large carbuncles and abscesses, as the plague does : Nay more, since it is observed by the Marquis, that the difference between the contagious distemper of 1745 and 1746, and of 1747 and 1748, was, that in the former the

(5) Pag. 143. and 338.

salutary eruptions appeared, but in the latter were, as he justly apprehends, checked by the excessive cold weather; and should it appear, that by inoculation the same regular eruptive fever has been produced, with every stage, and the same symptoms as arise in the small-pox; the nature of this distemper will then be ascertained.

I shall now proceed, my Lord, to lay before your Lordship and the Society the accounts I have received relating to the infection and inoculation of the cattle, and make some observations on the experiments made at Ilfurtille.

So long, my Lord, as the distemper has raged in Great Britain, not one attested proof has been brought of any beast having this disease regularly more than once. I make no doubt but these creatures may be liable to eruptions of different kinds; but as all sorts of eruptions, says Dr. Mead (6), are not the small-pox, nor measles, so every pustule is not a sign of the plague. Thro' ignorance, or fraud, persons may have been deceived in purchasing cattle, and have lost them, as well in England as in the provinces of France mentioned by the Marquis; but until a second infection be proved, the general opinion must prevail in this case, as in the small-pox: for tho' many have insisted on the same thing with regard to the small-pox, yet a single instance, properly vouched and attested, has never been produced, either after recovery from the natural way, or from inoculation; unless what is frequently the case with nurses and others attending the small-pox, that is, pustules

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(6) Essay on the Plague.

breaking out in their arms and face, be allowed as the signs of a second infection.

The farmers and graziers in Huntingdonshire, Cambridgeshire, Lincolnshire, Kent, and Yorkshire, from whence I have written testimonies, all agree, that they never knew of a beast having the contagious distemper more than once. In this county particularly, Mr. J. Mehew, the farmer mentioned in my Essay, has now among his stock at Godmanchester *eight cows*, which had the contagious distemper the first time it appeared in Godmanchester in 1746. It returned in 1749, 1755, and 1756; the two last not so generally over the town as the two former years. All these four times Mr. Mehew suffered by the loss of his cattle; yet those *eight cows*, which recovered in 1746, remained all the while the distemper was in the farm the three years it raged, were in the midst of the sick cattle, lay with them in the same barns, eat of the same fodder, nay of such as the distempered beasts had left and flabbered upon, drank after them, and constantly received their breath and steams, without ever being in the least affected. Is not this a convincing proof? If in general the cattle be susceptible of a second infection, how comes it, that not one of these *eight cows* were affected?

In the years abovementioned the distemper spared no beast, but such as had recovered from that disease: and this is confirmed to me by Mr. Mehew's father and brother, all the chief farmers of Godmanchester, and is the opinion of all the farmers and graziers in Huntingdonshire, who are so thoroughly convinced of there being no second infection, that  
they

they are always ready to give an advanced price for such cattle as have recovered from the contagious distemper.

The Rev. Mr. Scaife, assistant to the Rev. Dr. Greene, Dean of Salisbury, in his parish of Cotterham, Cambridgeshire, acquaints me, that the farmers in that neighbourhood lost, in 1746 and 1747, twelve hundred head of cattle, in 1751 four hundred and seventy; and tells me, that Mr. Ivett, Sayers, Moor, Dent, Lawfon, chief farmers at Cottenham, Mr. Taylor, Sumpter, and Matthews, of his own parish of Histon, and the farmers of Wivelingham alias Willingham, unanimously declare, they never had one instance of a beast having the distemper twice.

Mr. Thorpe, a farmer and grazier near Gainsborough in Lincolnshire, has had beasts recovered from the distemper, which have herded with cattle fallen ill afterwards, and never met with a single instance of a second infection.

Mr. Loftie, an eminent surgeon at Canterbury, has inquired for me of the farmers and graziers in that part of Kent, and about Romney-Marsh; and from whence no belief of a second infection can be had.

The Rev. Dr. Fountayne, Dean of York, writes me word, that no beast has been known, in his neighbourhood, to have had the distemper twice. And several persons from that county, and others, have told me the same thing.

If the above testimony of persons of character and veracity, together with the concurrent persuasion of farmers in general, be allowed of, it must be determined that there is no instance of a second infection. Supposing now it should appear, that this distemper

is

is regularly, as in the natural way, tho' in a milder manner, produced by inoculation, and that inoculation secures a beast also from a second infection; then undoubtedly inoculation will be recommendable.

The very few trials made in England, and those not with the greatest exactness or propriety, will yet serve to put this matter out of all doubt.

The Rev. Dean of York had five beasts inoculated, by means of a skein of cotton dipped in the matter, and passed thro' a hole, like a seaton, in the dew-lap. Of these five, one cow near the time of calving died: the other four, after going thro' the several stages of this contagious disease, recovered; two of which, being cows young with calf, did not slip their calves. All four have herded with distempered cattle a long while, and never had the least symptom of a second infection.

Mr. Bewley, a surgeon of reputation in Lincolnshire, inoculated three beasts two years old, for Mr. Wigglesworth of Manton, in the dew-lap, and with *mucus* from the nostrils. All three had the regular symptoms of the contagious distemper in a mild manner, recovered, and tho' they herded a twelve-month after with five or six distempered beasts, they never were the least affected. Mr. Bewley also declared to Mr. Thorpe, that there never was one instance produced, that he knew of, of a second infection.

Since it is plain, that notwithstanding neither well-digested *pus* was made use of, nor incisions made in the properest places, and it may be supposed few medicines were given; yet inoculation succeeded so



as to bring on the distemper in a regular and mild manner, as appears by the cows with calf not slipping their calves. One may fairly conclude, that in this contagious distemper, like unto the small-pox, the practice of inoculation is not only warrantable, but much to be recommended.

But how comes it then, that neither by application, digestion, nor inoculation, the distemper was not communicated in France?

The Marquis says, that this distemper is not communicated but from one beast to another immediately. I must beg leave to say, that to my knowledge the distemper in February 1756 was carried from the farm-yard, where I visited some distempered cattle, to two other farm-yards, each at a considerable distance, without any communication of the cattle with each other, and merely by the means of servants going to and fro, or of dogs.

The experiments made on four beasts, by tying over their heads part of distempered hides, or pieces of linen and woollen cloth or silk, which had received the breath and steams of dying cattle, serve to shew, by the bullock's forcing off the cloth tied about him, that the putrid stench was disagreeable to him; but that neither his blood, nor that of the other three beasts, was then in a state to receive the infection.

With regard to the pustules, which the Marquis relates were mixed with oats and bran, or dissolved in white wine; the distempered bile, which was mixed with milk; milk taken from diseased cows; water, in which part of a distempered hide had been steeped; and the precaution taken to force these

mixtures into the paunch of calves, by means of a funnel, whose end was covered with a piece of raw distempered skin, that the beast might both swallow and suck in the disease. All these experiments could have no other effect than what followed; which was, that the acrimony of the distempered bile created first a *nausea*, and then produced a violent scouring, which killed the beast, leaving marks of its irritation on the intestines.

The practice of inoculation is but lately followed, and even now but little known, in the provinces of France. Its advantages have not long since been strangely disputed at Paris. In the case of inoculating cattle, instead of a slip of raw hide taken from a beast just dead, or putting a pustule into the neck, they should either have passed in the dewlap cotton or silk dipped in well-digested *pūs*, or have inserted in proper incisions cotton-thread or silk soaked with *pūs* either on the shoulders or buttocks; the true way of inoculating in the English manner. Some persons have indeed thought, that to inoculate with the blood of the infected would answer the intention; but most of the modern practitioners chuse to depend on digested matter.

Several constitutions will not receive infection, let them be inoculated ever so judiciously. A Ranby, a Hawkins, a Middleton, and other inoculators, will tell us, that the incisions have sometimes suppurated so much, and pustules have appeared round the edges of the wound, without any other particular marks of the disease; and yet the patient has never had the small-pox afterwards. The Marquis mentions an instance somewhat of the same kind in his first *Memoir*, p. 147.

The examination of these very important and interesting particulars has, I observe, drawn me into a prolixity, which I fear may prove tedious to your Lordship: but should I have removed all doubts, and brought convincing proofs of the absurdity of fearing a second infection; should I have shewn inoculation to be a necessary practice, and that the contagious distemper may be communicated more ways than one; I hope your Lordship will excuse the length of this letter. I shall only add my earnest wishes, that the legislature may, by effectual means, prevent the importation of distempered cattle and hides into these kingdoms; the only means of naturalizing and perpetuating a dreadful distemper, now, thank God! much decreased among us.

I am, with the greatest respect,

My Lord,

Your Lordship's

Most humble and most obedient Servant,

Huntingdon,  
26 Nov. 1757.

Daniel Peter Layard.

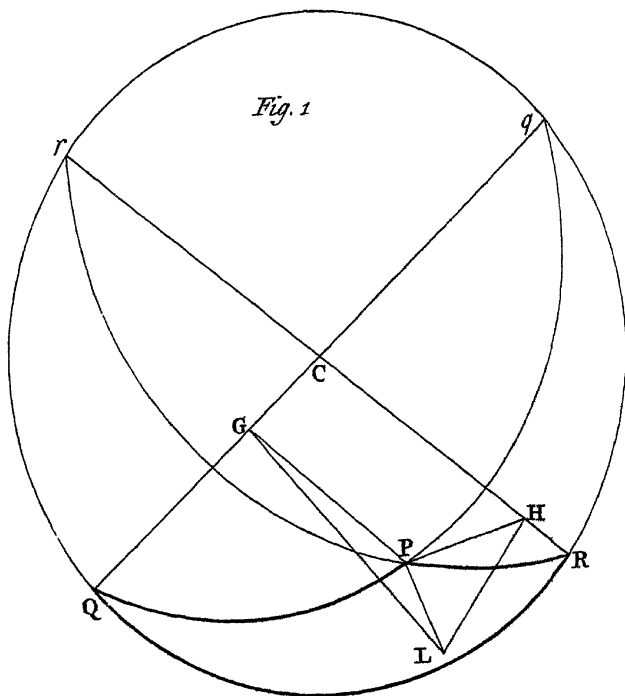
LXX. *Trigonometry abridged.* By the Rev.  
Patrick Murdoch, A. M. F. R. S.

Read Feb. 2, 1758. **T**HE cases in trigonometry, that can properly be called different from one another are no more than *four*; which may be resolved by *three* general rules or theorems, expressed  
§
in

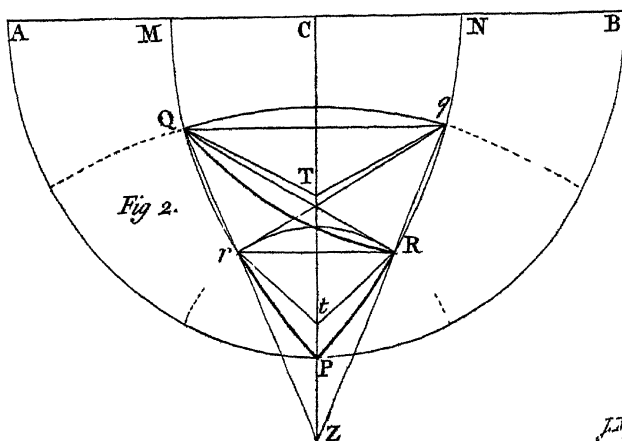




*Fig. 1*



*Fig 2.*



*J. Mynoe sc*



in the fines of arcs only; using the supplemental triangle as there is occasion.

## C A S E I.

*When of three given parts two stand opposite to each other, and the third stands opposite to the part required.*

## T H E O R E M I.

*The fines of the sides are proportional to the fines of angles opposite to them.*

## D E M O N S T R A T I O N.

Let  $QR$  (TAB. XX. Fig. I.) be the base of a spherical triangle; its sides  $PQ$ ,  $PR$ , whose planes cut that of the base in the diameters  $QCq$ ,  $RCr$ . And if, from the angle  $P$ , the line  $PL$  is perpendicular to the plane of the base, meeting it in  $L$ , all planes drawn through  $PL$  will be perpendicular to the same, by 18. *el.* 11. Let two such planes be perpendicular likewise to the semicircles of the sides, cutting them in the straight lines  $PG$ ,  $PH$ ; and the plane of the base in the lines  $LG$ ,  $LH$ .

Then the plane of the triangle  $PGL$  being perpendicular to the two planes, whose intersection is  $QGCq$ , the angles  $PGQ$ ,  $LGQ$  will be right angles, by 19. *el.* 11.  $PG$  likewise subtends a right angle  $PLG$ , and the angle  $PGL$  measures the inclination of the semicircle  $QPq$  to the plane of the base (*def.* 6. *el.* 11.) that is (by 16 *el.* 3. and 10 *el.* 11.) it is equal to the spherical angle  $PQR$ : whence  $PG$  is to  $PL$  as the radius to the sine of  $PQR$ . The same way  $PL$  is to  $PH$  as the sine of  $PRQ$  is to the



the radius : and therefore, *ex æquo*, PG the sine of the side PQ is to PH the sine of PR, as the sine of PRQ is to the sine of PQR.

## CASES II. and III.

*When the three parts are of the same name.*

And,

*When two given parts include between them a given part of a different name, the part required standing opposite to this middle part.*

## THEOREM II.

*Let S and s be the sines of two sides of a spherical triangle, d the sine of half the difference of the same sides, a the sine of half the included angle, b the sine of half the base; and writing unity for the radius, we have  $Ss a^2 + d^2 - b^2 = 0$ ; in which a or b may be made the unknown quantity, as the case requires.*

## DEMONSTRATION..

Let PQR (Fig. 2.) be a spherical triangle, whose sides are PQ PR, the angle included QPR, the base QR, PC the semiaxis of the sphere, in which the planes of the sides intersect.

To the pole P, draw the great circle AB, cutting the sides (produced, if needful) in M and N; and thro' Q and R, the lesser circles Qq, rR, cutting off the arcs Qq, qR equal to the difference of the sides; join MN, Qq, rR, QR, qr.

Then the planes of the circles described being parallel (*Theod. sphaeric.* 2. 2.), and the axis PC perpendicular to them (10. 1. of the same), their intersections

tions with the planes of the sides, as  $QT$ , and  $Rt$ , will make right angles with  $PC$ ; that is,  $QT$  and  $Rt$  are the sines ( $S, s.$ ) of the sides  $PQ, PR$ , and  $MC, NC$  are whole sines. Now the isosceles triangles  $MCN, QTq, rtR$ , being manifestly similar; as also  $MN$ , the subtense of the arc which measures the angle  $QPR$ , being equal to  $(2a)$  twice the sine of half that angle; we shall have  $MN:MC::Qq:QT::rR:Rt$ ; or, in the notation of the theorem,  $Qq = 2Sa, rR = 2sa$ . And further, the chords  $Qr, qR$  being equal, and equally distant from the center of the sphere, as also equally inclined to the axis  $PC$ , will, if produced, meet the axis produced, in one point  $Z$ . Whence the points  $Q, q, R, r$ , are in one plane (*2. el. 11.*), and in the circumference in which that plane cuts the surface of the sphere: the quadrilateral  $QqRr$  is also a segment of the isosceles triangle  $ZQq$ , cut off by a line parallel to its base, making the diagonals  $QR, qr$ , equal. And therefore, by a known property of the circle,  $Qq \times rR + qR^2 = QR^2$ ; which, substituting for  $Qq$  and  $Rr$  the values found above,  $2d$  for  $Qr$ ,  $2b$  for  $QR$ , and taking the fourth part of the whole, becomes  $S.s a^2 + d^2 = b^2$ , the proposition that was to be demonstrated.

*Note 1.* If this, or the preceding, is applied to a plane triangle, the sines of the sides become the sides themselves; the triangle being conceived to lie in the surface of a sphere greater than any that can be assigned.

*Note 2.* If the two sides are equal,  $d$  vanishing, the operation is shorter: as it likewise is when one or both sides are quadrants.

*Note*

*Note 3.* By comparing this proposition with that of the Lord Neper ‡, which makes the 39th of Keill's Trigonometry, it appears, that if AC, AM, are two arcs, then  $\text{fin. } \frac{AC + AM}{2} \times \text{fin. } \frac{AC - AM}{2} = (\overline{b + d} \times \overline{b - d} =) \text{fin. } \frac{1}{4} AC + \text{fin. } \frac{1}{4} AM \times \text{fin. } \frac{1}{4} AC - \text{fin. } \frac{1}{4} AM$ . And in the solution of Case II. the first of these products will be the most readily computed.

#### CASE IV.

*When the part required stands opposite to a part, which is likewise unknown :* Having from the data of Case I. found a fourth part, let the fines of the given sides be S, s; those of the given angles  $\Sigma, \sigma$ ; and the fines of half the unknown parts a and b; and we shall have, as before,  $Ss a^2 + d^2 - b^2 = 0$ ; and if the equation of the supplements be  $\Sigma \sigma \alpha^2 + \delta^2 - \beta^2 = 0$ ; then, because  $\alpha^2 = 1 - b^2 = 1 - Ss a^2 + d^2$ , and  $\beta^2 = 1 - a^2$ , substituting these values in the second equation, we get

#### THEOREM III.

$$\frac{1 - \Sigma \sigma \times \overline{1 - d^2} - \delta^2}{1 - Ss \Sigma \sigma} = a^2; \text{ in words thus:}$$

*Multiply the product of the fines of the two known angles by the square of the cosine of half the difference of the sides : add the square of the sine of half the difference of the angles ; and divide the complement of this*

‡ See Logarith. Canon, defer. Edinb. 1614. p. 48.

*sum to unity, by the like complement of the product of the four sines of the sides and angles; and the square root of the quotient shall be the sine of half the unknown angle.*

If we work by logarithms, the operation will not be very troublesome; but the rule needs not be used, unless when a table of the trigonometrical analogies is wanting. To supply which, the foregoing theorems will be found sufficient, and of ready use; being either committed to memory, or noted down on the blank leaf of the trigonometrical tables.

*Note,* The schemes may be better, raised in card-paper, or with bent wires and threads.

**LXXI.** *An Account of Two extraordinary Cases of Gall-Stones.* By James Johnstone, M. D. of Kidderminster. Communicated by the Rev. Charles Lyttelton, L. L. D. Dean of Exeter.

*To the Rev. Dr. Lyttelton, Dean of Exeter.*

Rev. Sir,

Read Feb. 9.  
1758.

**A**CCORDING to promise I send you a short account of the two extraordinary cases we talked of, the last time I had the pleasure of seeing you at Kidderminster.

The truth of the first narrated case you are already a sufficient judge of; and if it is at all necessary to ascertain

ascertain the second in like manner, I can at any time produce the poor woman and her husband before you, who will attest the truth of sufferings, which will not easily escape their memory.

You are at liberty to dispose of this paper as you shall think proper. I am,

Reverend Sir,

Your respectful and most humble Servant,

Kidderminster,  
Sept. 11. 1757.

J. Johnstone.

**T**H<sup>O'</sup> it is now pretty well known, that colicky and icteric diseases often arise from gall-stones generated in the bilious receptacle, and obstructing its canals; yet an example of one, of such enormous size, voided into the *duodenum* from the *ductus communis*, as happened in the first of the following cases, is a very rare, if not intirely an unexampled occurrence. It will encourage us not too easily to despair of the expulsion of the largest *calculi* from the gall-bladder; and will teach us, that all violent attacks of pain about the stomach are not owing to gout reflected upon that organ: it will make us more cautious of giving drastic cathartics, heating and inflaming medicines, upon such a vague presumption; and ought to dispose those, who are trusted with the lives of their fellow-creatures, to a nicer observation of even the minutest symptoms and circumstances, which may occur in diseases.

The second case points out, under certain circumstances, the practicability of extracting, by incision into  
the

the gall-bladder itself, those *calculi*, which, from their figure, or other impediments, cannot be voided in the natural way. The method of performing this unusual operation, and some instances of its success, have already been made public in the *Memoires de l'Acad. de Chirurg.*

1. Mrs. F——, a sedentary corpulent old lady, had been much subject to colicky complaints, without jaundice, in the vigour of life. The seat of the pain was chiefly under the right *hypochondrium*, as high as the stomach. She had been tolerably free from it for at least eight years past. December 5, 1753, about eleven o'clock in the evening, she was suddenly seized with a violent pain, extending from that part of the stomach lying under the right side, thro' to her back. She compared it to a sword driven in that direction. This pain continued not only with unremitted violence, but even increased, till seven o'clock in the morning: all this time she vomited and strained almost incessantly; but after her stomach was emptied of its contents, nothing came up besides clear slime, streaked with blood. About seven o'clock in the morning she felt her pain fall or move lower, as she expressed it, and from that time became remarkably easier. Soon after this change, she became extremely sick, and vomited up, for the first time, a prodigious quantity of greenish yellow bile. She had not before this seizure been remarkably constive; and in her pain had a free motion to stool with effect; but during the remainder of the (6th) day had none, tho' all this time emollient clysters were injected; and she took regularly

every two hours a powder of *magnes. alb. terr. fol. tartar. tart. vitriol. ana* ʒj. *ol. nuc. mosch. gutt. j.* with a draught of the *succ. limon.* & *sal. absinth.* But in the middle of the night, and all day (the 7th), she had an abundant discharge of loose bilious stools. She had continued free from excessive pain since the morning of the former day, only now and then complained of uneasiness sometimes in one, sometimes in another, part of her bowels. About twenty-four hours after her first seizure, she felt a great pain striking towards the bottom of her back, and one hour after voided the extraordinary *calculus*, of which the figure and description are subjoined. Some time after pieces of skins were voided by stool, which were evidently of the texture and appearance of the internal villous coat of the intestines and gall-bladder. The above medicines were the only ones she used, by my direction, under her painful complaint, excepting an external fomentation, and bleeding, which the hardness and contractedness of her pulse seemed to require. She was ordered to drink plentifully of thin broths, and other soft diluent liquors. During the course of her disorder she had no appearance of jaundice, nor since; and, considering her years, enjoys at present (Sept. 1757) very good health.

This *calculus*, as appears by the figure, was of a pyriform shape, resembling the form of the *cystis fellea* itself. Its surface was quite smooth and polished, excepting towards the base, at that part marked A, where it was scabrous, as if some other substance had lain contiguous to it. When broken through, it was composed of concentric laminæ, which were alternately white and ochre-coloured. In length it  
measured

measured one inch and three tenths; its transverse section measured at least seven tenths of an inch. It had a saponaceous smoothness, like other gall-stones, and floated upon water. It weighed only about 126 grains.

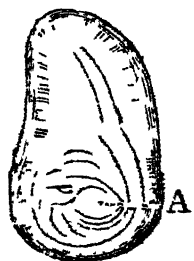
Tho' it be difficult to conceive, how so bulky a substance, generated in the gall-bladder, could be conveyed along so narrow a passage as the common biliary duct, especially considering the obliquity of its insertion for near half an inch of length betwixt the coats of the *duodenum*; yet there seem sufficient *data* in the above case to prove, that this animal stone was not formed in the alimentary tube, but (large as it was) had come into it from the *ductus communis choledochus*.

The shape and saponaceous smoothness, and colour of the laminæ, of this substance, shew it was moulded in the gall-bladder, and formed from bilious particles. The severe pain and torture, and enormous vomiting, she underwent, for seven hours after her first seizure, argue, that it must then be lodged in some canal much narrower and straighter than the alimentary canal; for so soon as it dropped into that, the severe pain in a great measure ceased.

But that straight canal, in which it was situated during those seven hours of torture, could be no other than the *ductus communis choledochus*; for, during this space of time, no bile was emptied into the bowels, nor thrown up by the strongest efforts of vomiting. But no sooner had she perceived the cause of her pain to move or drop downwards (a sensation, which points out the precise moment the stone must have dropped into the *duodenum*), than



she began to sicken, and instantly after vomited up a vast quantity of bilious matter; which now from the de-obstructed duct, began to flow freely into the *duodenum*. The obstruction of the *ductus choledochus* was of too short a duration (only three hours) to occasion any observable jaundice. And it appears by the bloody flesh-like knots, thrown up with phlegm by vomiting, that the passage of the substance was not effected without considerable laceration of the small bilious ducts. And this easily accounts for the separation of the villous coat, which afterwards appeared in this patient's stools.



This coarse delineation represents the figure and true bulk of the *calculus*; which, I believe, is still in my patient's custody.

2. In February 1752. I was called to relieve a poor woman of this place, Sarah Ewdall, aged 30 years and upwards, and the mother of several children. She laboured under the jaundice, and complained of a severe acute pain striking thro' from the right *hypochondrium* to her back, with frequent vomitings. A praternatural hardness, of a compass not exceeding the hollow of the hand, was then plainly to be felt at the pit of the stomach, or a little nearer to the right *hypochondrium*. When that particular part was pressed, she complained of great pain. The pain at this part was always increased by attempting to lie upon the left side. She was blooded,

blooded, fomented externally, had emollient saponaceous clysters injected, and a nitrous apozem, and pills composed of *galban.* & *sap. Castillensj.* and soon after recovered. She had frequent returns of the same complaint after this; but I saw her not again till Jan. 1755, when she lay insensible in a fit, which for several days deprived her of the use of her speech and of all her senses, only she tossed her limbs about. About a quarter of a year after she had recovered from this fit, Mr. Cooper of this place, her apothecary, informed me, that from a small sore at the pit of her stomach, which came since her last illness, she had voided several gall-stones. Curiosity prompted me to inquire into the matter of fact from herself. She shewed me the sore, which was now almost cicatrized. She said, that soon after her last illness a little pimple arose upon that part of the pit of the stomach, which had been hard ever since she had been subject to the jaundice. This pimple broke, ran matter, and at different times the *calculi*, which she shewed me, had come out with the matter. Her stomach had been somewhat painful before it broke, but was now easy. The *calculi*, which she shewed me, had the appearance of being fragments of larger ones, and some were almost dust; tho' she assured me they all came from the sore in that condition. Of these fragments I have two or three of the largest now in my custody: they are light, swim on water, smooth like soap; are of a yellow colour, and in some parts brown like snuff; and consist of similar concentrical layers. The poor woman has since then been troubled with returns of pain and jaundice, in the intervals of which her skin is perfectly clear

and white. She is still alive, and ready to attest the truth of this narrative.

Kidderminster,  
Sept. 11th, 1757.

J. Johnstone.

**LXXII.** *A remarkable Case of Cohesions of all the Intestines, &c. in a Man of about Thirty-four Years of Age, who died some time last Summer, and afterwards fell under the Inspection of Mr. Nicholas Jenty.*

Read Feb. 9, 1758. **T**HE subject was tall, and partly emaciated. I found nothing externally but a wound in the left side, which seemed to me to have been degenerated into an ulcer. As I did not know the man when he was alive, and had him two days after his decease, I cannot give an immediate account of the cause of his death. But in opening his abdomen, I found the epiploon adhering close to the intestines, in such a manner, that I could not part it without tearing it. It felt rough and dry. And as I was going to remove the intestines, to examine the mesentery, I found them so coherent one with the other, that it was impossible for me to divide them without laceration. Then I inflated the intestinal tube, for the inspection of this extraordinary phenomenon; but, to my great surprize, all the external parts of the intestines appeared smooth; very few of the circumvolutions were seen, occasioned by the strong lateral cohesions of their sides with

with each other. The substance of the intestines was rough, and a great many pimples, as big as the head of a pin, appeared in them, and were almost free from any moisture. It is proper to observe, that these pimples have been taken for glands by the late Dr. James Douglas, and others; whereas they are in reality nothing else but the orifices of the exhaling vessels obstructed, and are not to be met with except in morbid cases.

After having made incisions in that part of the *colon* next to the *rectum*, I found the *peritonæum*, or external membrane which invests the intestines, and the *viscera* of the *abdomen*, to be of the thickness of a six-pence; and I fairly drew all the intestines from their external membrane without separating their cohesions; the *peritonæum*, or external membrane, afterwards appearing like another set of intestines. I found a fluid in the intestines; and I will not take upon me to say, how the peristaltic motion must have been performed. And afterwards I parted the stomach from its external tunic, as I had done the intestines. I found no obstruction in the mesenteric glands; but every evolution of the mesentery firmly cohered together. The liver also adhered closely to the diaphragm, and its adjacent parts: and in the *vesicula fellea* I found the bile pretty thick, neither too green nor too yellow, but a tint between both. I met with nothing remarkable in the other parts of the *abdomen*: In opening the *thorax*, I found the lungs closely adhering to the ribs laterally, and posteriorly and anteriorly close to the *pericardium*. In making an incision to open the *pericardium*, I found it so closely adhering to the heart, that I could not

avoid wounding that organ, and with much difficulty could part it from it. I met with no fluid in the *pericardium*. The heart was small; and in the internal side the pores of the *pericardium* appeared so large, that one might have insinuated the head of a middling pin into them. They have been described by some anatomists, who have met with cases somewhat similar to this, but without such universal adhesions; and they have been supposed to have been glands. The same pores likewise appeared on the heart; which, in my opinion, are nothing but the extremities of the exhaling vessels. In removing the heart, I found the *dorsal*, and other lymphatic glands above the lungs, quite large, indurated, and of a dark greyish colour. Nothing remarkable appeared in the lungs; only, that the portion of the *pleura*, which invests the lungs, and is generally thin, was here thick and rough; and thro' a glass it appeared as if covered with grains of sand; and might in several places have been easily torn from the lungs.

The *aorta* was pretty large; and in that part of it, which runs on the tenth *dorsal vertebra*, I found a *cystis*, as big as an olive, full of *pus*; and lower down, immediately before that vessel perforates the diaphragm, I found another, something less, full of matter likewise; both which portions I have by me. That portion of the *aorta*, where the *cystis* appeared, was rather thicker than the other, and osseous. In opening the *cranium*, I found in that part of the *cerebrum*, which lies over the *cerebellum*, a table spoon-full of *pus*, of a greenish colour; and examining it thro' a glass, there was an appearance of *animalcula* in it.

LXXIII. *Of the best Form of Geographical Maps.* By the Rev. Patrick Murdoch, M. A. F. R. S.

Read Feb. 9, I. <sup>1758.</sup> **W**HEN any portion of the earth's surface is projected on a plane, or transferred to it by whatever method of description, the real dimensions, and very often the figure and position of countries, are much altered and misrepresented. In the common projection of the two hemispheres, the meridians and parallels of latitude do indeed intersect at right angles, as on the globe; but the linear distances are every-where diminished, excepting only at the extremity of the projection: at the center they are but half their just quantity, and thence the superficial dimensions but one-fourth part: and in less general maps this inconvenience will always, in some degree, attend the *stereographic* projection.

The *orthographic*, by parallel lines, would be still less exact, those lines falling altogether oblique on the extreme parts of the hemisphere. It is useful, however, in describing the circum-polar regions: and the rules of both projections, for their elegance, as well as for their uses in astronomy, ought to be retained, and carefully studied. As to Wright's, or Mercator's, nautical chart, it does not here fall under our consideration: it is perfect in its kind; and will always be reckoned among the chief inventions of the last age. If it has been misunderstood, or misapplied, by geographers, they only are to blame.

II. The particular methods of description proposed or used by geographers are so various, that we might, on that very account, suspect them to be faulty; but in most of their works we actually find these two blemishes, *the linear distances visibly false*, and *the intersections of the circles oblique*: so that a quadrilateral rectangular space shall often be represented by an oblique-angled rhomboid figure, whose diagonals are very far from equal; and yet, by a strange contradiction, you shall see a fixed scale of distances inserted in such a map.

III. The only maps I remember to have seen, in which the last of these blemishes is removed, and the other lessened, are some of P. Schenk's of Amsterdam, a map of the Russian empire, the *Germania Critica* of the famous Professor Meyer, and a few more ‡. In these the meridians are straight lines converging to a point; from which, as a center, the parallels of latitude are described: and a rule has been published for the drawing of such maps\*. But as that rule appears to be only an easy and convenient approximation, it remains still to be inquired, *What is the construction of a particular map, that shall exhibit the superficial and linear measures in their truest proportions?* In order to which,

IV. Let  $E/LP$ , in this figure (See TAB. XXI.) be the quadrant of a meridian of a given sphere, whose center is  $C$ , and its pole  $P$ ;  $EL$ ,  $E'l$ , the latitudes of two places in that meridian,  $EM$  their

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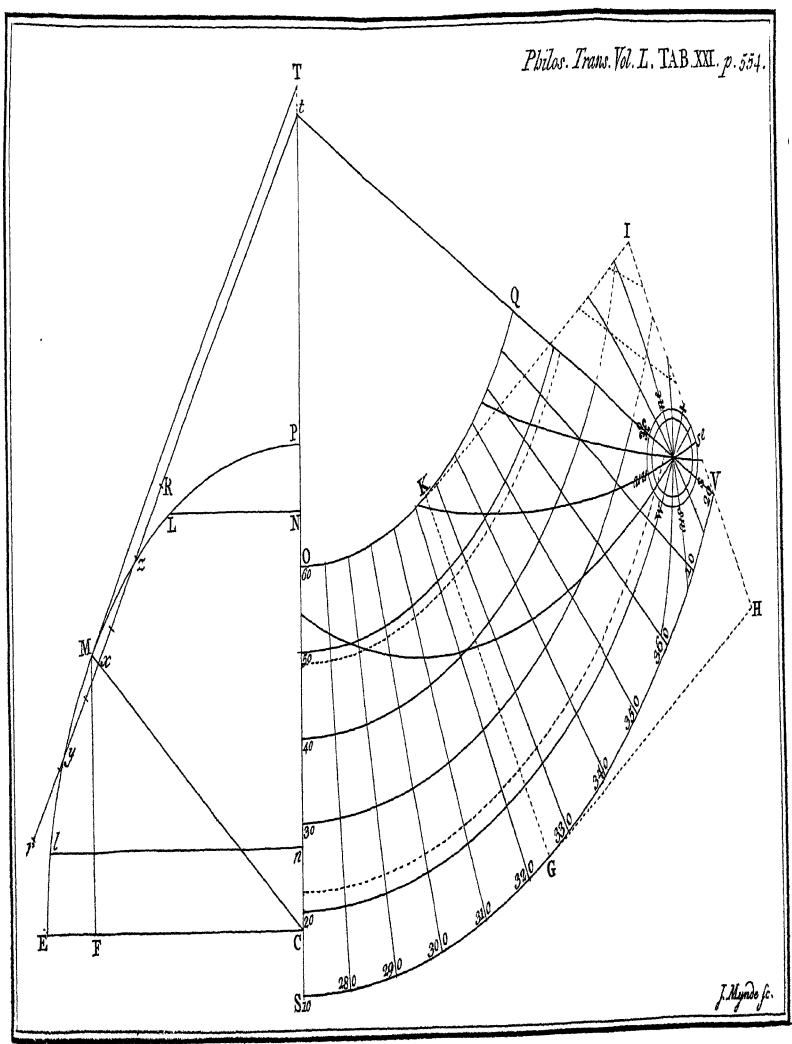
‡ *Senex* drew several of that form.

\* See the Preface to the small Berlin Atlas.









*J. Mynors sc.*



middle latitude. Draw  $LN$ ,  $ln$ , cofines of the latitudes, the sine of the middle latitude  $MF$ , and its cotangent  $MT$ . Then writing unity for the radius, if in  $CM$  we take  $Cx = \frac{Nn}{Ll \times MF \times MT}$ , and thro'  $x$  we draw  $xR$ ,  $xr$ , equal each to half the arc  $Ll$ , and perpendicular to  $CM$ ; the conical surface generated by the line  $Rr$ , while the figure revolves on the axis of the sphere, will be equal to the surface of the zone that is to be described in the same time by the arc  $Ll$ ; as will easily appear by comparing that conical surface with the zone, as measured by *Archimedes*.

And, lastly, If from the point  $t$ , in which  $rR$  produced meets the axis, we take the angle  $CtV$  in proportion to the longitude of the proposed map, as  $MF$  the sine of the middle latitude is to radius, and draw the parallels and meridians as in the figure, the whole space  $SOQV$  will be the proposed part of the conical surface expanded into a plane; in which the places may now be inserted according to their known longitudes and latitudes.

# EXAMPLE.

V. Let  $Ll$ , the breadth of the zone, be  $50^\circ$ , lying between  $10^\circ$  and  $60^\circ$  north latitude; its longitude  $110^\circ$ , from  $20^\circ$  east of the Canaries to the center of the western hemisphere; comprehending the western parts of Europe and Africa, the more known parts of North America, and the ocean that separates it from the old continent.

And because  $Cx = \frac{Nn}{Ll \times MF \times MT}$ , add these three logarithms.

4 B 2

Log.

Log. 0.8726650 (= 50° to radius 1)	— 1.9408476
Log. MF (fin. 35°)	— 1.7585913
Log. MT (tang. 55°)	0.1547732
Take the sum	— 1.8542121
from log. Nn (= .6923772)	— 1.8403427
the remainder	— 1.9861306
is the logarithm of Cx. And because 1:	
Cx :: MT : xt, to this adding the log. MT	0.1547732

The sum . . . . . 0.1409038  
is the log. of  $xt = 1.383260$ ; and  $xR (= xr = \frac{1}{2} L)$  being .4363325,  $Rt$  will be 0.9469275,  $rt = 1.8195925$ . Whence having fixed upon any convenient size for our map, the center  $t$  is easily found. As, allowing an inch to a degree of a great circle, or 50 inches to the line  $Rr$ ,  $Rt$  the femidiameter of the least parallel will be 54.255 inches, and that of the greatest parallel 104.255 inches.

Again, making as radius to MF so the longitude 110° to the angle  $StV$ , that angle will be  $63^{\circ} 5' \frac{3}{4}$ . Divide the meridians and parallels, and finish the map as usual.

*Note,* The log. MT being repeated in this computation with a contrary sign, we may find  $xt$  immediately by subtracting the sum of the logarithms of  $L$  and MF from the log. of  $Nn$ .

VI. A map drawn by this rule will have the following properties :

1. The intersections of the meridians and parallels will be rectangular.

2. The

2. The distances north and south will be exact; and any meridian will serve as a scale.

3. The parallels thro'  $x$  and  $y$ , where the line  $Rr$  cuts the arc  $Ll$ , or any small distances of places that lie in those parallels, will be of their just quantity. At the extreme latitudes they will exceed, and in mean latitudes, from  $x$  towards  $z$  or  $y$ , they will fall short of it. But unless the zone is very broad, neither the excess nor the defect will be any-where considerable.

4. The latitudes and the superficies of the map being exact, by the construction, it follows, that the excesses and defects of distance, now mentioned, compensate each other; and are, in general, of the least quantity they can have in the map designed.

5. If a thread is extended on a plane, and fixed to it at its two extremities, and afterwards the plane is formed into a pyramidal or conical surface, it may be easily shewn, that the thread will pass thro' the same points of the surface as before; and that, *conversely*, the shortest distance between two points in a conical surface is the right line which joins them, when that surface is expanded into a plane. Now, in the present case, the shortest distances on the conical surface will be, if not equal, always nearly equal, to the correspondent distances on the sphere: and therefore, all rectilinear distances on the map, applied to the meridian as a scale, will, nearly at least, shew the true distances of the places represented.

6. In maps, whose breadth exceeds not  $10^{\circ}$  or  $15^{\circ}$ , the rectilinear distances may be taken for sufficiently exact. But we have chosen our example of a greater breadth than can often be required, on purpose

pose to shew how high the errors can ever arise; and how they may, if it is thought needful, be nearly estimated and corrected.

Write down, in a vacant space at the bottom of the map, a table of the errors of equidistant parallels, as from five degrees to five degrees of the whole latitude; and having taken the mean errors, and diminished them in the ratio of radius to the sine of the mean inclination of the line of distance to the meridian, you shall find the correction required; remembering only to distinguish the distance into its parts that lie *within* and *without* the sphere, and taking the difference of the correspondent errors, in *defect* and in *excess*.

But it was thought needless to add any examples; as, from what has been said, the intelligent reader will readily see the use of such a table; and chiefly as, whenever exactness is required, it will be more proper, and indeed more expeditious, to compute the distances of places by the following canon.

*Multiply the product of the cosines of the two given latitudes by the square of the sine of half the difference of longitude; and to this product add the square of the sine of half the difference of the latitudes; the square root of the sum shall be the sine of half the arc of a great circle between the two places given.*

Thus, if we are to find the true distance from one angle of our map to the opposite, that is, from S to Q, the operation will be as follows:

L. fin.

L. fin.  $30^{\circ} = -1.6989700$   
 L. fin.  $80^{\circ} = -1.9933515$   
 2 L. fin.  $55^{\circ} = -1.8267290$

$-1.5190505 = \log. \text{ of } 0.330408$   
 and 2 L. fin.  $25^{\circ} = -1.2518966 = \log. \text{ of } 0.178606$

Log. of the sum . . . 0.509014 is  $-1.7067297$   
 Whose half is  $-1.8533648$

the L. fin. of  $45^{\circ} 31'$ , the double of which is  $91^{\circ} 2'$ , or 5462 geographical miles.

And seeing the lines TS, TQ, reduced to minutes of a degree, are 6255.189 and 3255.189 respectively. and the angle STV is  $63^{\circ} 5'\frac{3}{4}$ , the right line SQ on the map will be 5594', exceeding its just value by 132' or  $\frac{1}{42}$  of the whole.

7. The errors on the parallels increasing fast towards the north, and the line SQ having, at last, nearly the same direction, it is not to be wondered that the errors in our example should amount to  $\frac{1}{42}$ . Greater still would happen, if we measured the distance from O to Q by a straight line joining those points: for that line, on the conic surface, lying every-where at a greater distance from the sphere than the points O and Q, must plainly be a very improper measure of the distance of their correspondent points on the sphere. And therefore, to prevent all errors of that kind, and confine the other errors in this part of our map to narrower bounds, it will be best to terminate it towards the pole by a straight line KI touching the parallel OQ in the middle point K, and on the east and west by lines, as HI, parallel to the meridian thro' K, and meeting the tangent at the middle point of the parallel SV in H. By this means too we shall gain more space than we lose, while the map takes the usual rectangular



rectangular form, and the spaces G H V remain for the *title*, and other inscriptions.

VII. Another, and not the least considerable, property of our map is, that it may, without sensible error, be used as a sea-chart; the rumb-lines on it being logarithmic spirals to their common pole  $t$ , as is partly represented in the figure: and the arithmetical solutions thence derived will be found as accurate as is necessary in the art of sailing.

Thus if it were required to find the course a ship is to steer between two ports, whose longitudes and latitudes are known, we may use the following

#### R U L E.

*To the logarithm of the number of minutes in the difference of longitude add the constant logarithm \* — 4.1015105, and to their sum the logarithm sine of the mean latitude, and let this last sum be S.*

*The cotangent of the mean latitude being T, and an arithmetical mean between half the difference of latitude and its tangent being called m, from the logarithm of  $T + m$  take the logarithm of  $T - m$ , and let the logarithm of their difference be D; then shall  $S - D$  be nearly the logarithm tangent of the angle, in which the ship's course cuts the meridians.*

*Note, We ought, in strictness, to use the ratio of  $t x + x R$  to  $t x - x R$  instead of  $T + m$  to  $T - m$ ; but we substitute this last as more easily computed, and very little different.*

\* This constant logarithm contains the reduction of the diff. of longitude to parts of radius unity, and to Briggs's Modulus.

EXAMPLE 1.

Let the latitudes, on the same side of the equator, be  $10^{\circ}$  and  $60^{\circ}$ ; then the middle latitude and its complement are  $35^{\circ}$  and  $55^{\circ}$ , and half the difference of the latitudes is  $25^{\circ}$ : and the difference of longitude being  $110^{\circ}$ , the operation will stand as below.

$$\begin{array}{r}
 \text{Log. } 6600' \text{ (in } 110^{\circ}) \dots 3.8195439 \\
 \text{Constant log.} \dots -4.1015105 \\
 \hline
 \phantom{\text{Log. } 6600' \text{ (in } 110^{\circ})} \dots -1.9210544 \\
 \text{Log. fin. } 35^{\circ} \dots -1.7585913 \\
 \hline
 S = \dots -1.6796457
 \end{array}$$

$$\begin{array}{l}
 \text{Again } T = 1.4281480 \\
 m = .4513202
 \end{array}$$

$$\begin{array}{r}
 \text{Log. } T+m (=1.8794682) \dots 0.2740350 \\
 \text{Log. } T-m (=0.9768278) \dots -1.9898180
 \end{array}$$

$$\text{Log. } 0.2842170 = D = -1.4536500$$

$S - D (= \log. \text{tangent } 59^{\circ} 16') \dots = 0.2259957$   
 agreeing to a minute with the solution by a table of meridional parts.

EXAMPLE 2.

The rest remaining, let the difference of longitude be only  $40^{\circ}$ ; then

$$\begin{array}{r}
 \text{Log. } 2400' \text{ (in } 40^{\circ}) \dots 3.3802112 \\
 \text{Constant log.} \dots -4.1015105
 \end{array}$$

$$\begin{array}{r}
 \phantom{\text{Log. } 2400' \text{ (in } 40^{\circ})} \dots -1.4817217 \\
 \text{Log. fin. } 35^{\circ} \dots -1.7585913
 \end{array}$$

$$S = \dots -1.2403130$$

$$D \text{ (as before)} = -1.4536500$$

$$S - D (= \log. \text{tang. } 31^{\circ} 27' \frac{1}{2}) \dots -1.7866630$$

EXAMPLE 3.

Let the difference of longitude be  $40^{\circ}$ ; but the latitudes  $56^{\circ}$  and  $80^{\circ}$ ;

$$\left. \begin{array}{l} \text{And log. } 2400' \\ + \text{log. constant} \end{array} \right\} = -1.4817217$$

$$\text{Log. fin. } 68^{\circ} \dots = -1.9671659$$

$$S = \dots - 1.4488876$$

$$T (\text{tang. } 22^{\circ}) = .4040262$$

$$m = \dots .2109980$$

$$\text{Log. } T + m (= .6150242) = 1.7888921$$

$$\text{Log. } T - m (= .1830282) = 1.2625181$$

$$\text{Log. } \dots 0.5263740 = D = -1.7212944$$

$$S - D (= \text{log. tangent } 28^{\circ} 6') \dots = -1.7275932$$

wanting of the true answer no more than  $1^{\circ} 4'$ .

And in all cases that can occur, the error of this rule will be inconsiderable.

It is not meant, however, that it ought to take place of the easier and better computation by a table of meridional parts: but it was thought proper to shew, by some examples, how safely the map itself may be depended on in the longest voyages; provided it is sufficiently large, and the necessary rumb-lines are exactly drawn\*.

\* See *Catæfi Logometr.* prop. 6.

LXXIV. *A short Dissertation on Maps and Charts: In a Letter to the Rev. Thomas Birch, D. D. and Secret. R. S. By Mr. Wm. Mountaine, F. R. S.*

S I R,

London, March 21. 1758.

Read April 6.  
1758.

**A**MONG the several improvements made in arts and sciences by ingenious men, the construction of *globes, maps, or charts*, deserves a place: not only on account of the pleasure and satisfaction that arises to speculative minds, in surveying the extent and divisions of this terraqueous globe, but also for their real use and service to navigation, trade, and commerce.

*Globes* perhaps were first invented, as bearing the nearest semblance to the natural form of the earth and sea, with proper circles thereon described, and the several empires and kingdoms, according to their extent, latitudes, and longitudes, as far as geography and history would admit.

But tho' these convey the most general and truest ideas of the position and situation of places; yet, as containing but a small surface, they were found not extensive enough to take in particular kingdoms or states, with their subdivisions, cities, and rivers, so as to convey an adequate and sufficient representation. Besides, they were not so portable and commodious in voyages or travels.

*Maps and Charts* were therefore thought of, as being most convenient for both the purposes above-

mentioned ; the accuracy of which depends on representing the meridians and parallels in such manner, that when places are laid thereon, according to their latitudes and longitudes, they may have such respect to each other, as they have on the globe itself ; and those are either *globular* or *rectilinear*.

*Globular*, or *curvilinear*, are either general or particular.

*General*, are the hemispheres ; for the most part constructed stereographically.

*Particular*, contain only some part of the terraqueous globe ; and of this sort there are sundry modes of construction, which for the most part are defective, so as not to be applied with accuracy and facility to the purposes intended, in determining the courses or bearings of places, their distances, or both.

*Rectilinear* were therefore very early adopted, on which the meridians were described parallel to each other, and the degrees of latitude and longitude everywhere equal ; the rumbs were consequently right lines ; and hereby it was thought, that the courses or bearings of places would be more easily determined.

But these were found also insufficient and erroneous, the meridians being parallel, which ought to converge ; and no method or device used to accommodate that parallelism.

Notwithstanding the great deficiency in this plane map or chart, it was preferred, especially in nautical business ; and hath its uses at this day in topographic constructions, as in bays, harbours, and very narrow zones.

However,

However, the errors herein were sooner discovered than corrected, both by mathematicians and mariners, as by Martin Cortese, Petrus Nonius, Coignet, and some say by Ptolemy himself.

The first step towards the improvement of this chart was made by Gerardus Mercator, who published a map about the year 1550, wherein the degrees of latitude were increased from the equator towards each pole; but upon what principles this was constructed, he did not exhibit.

About the year 1590, Mr. Edward Wright, an Englishman, discovered the true principles upon which such a chart should be constructed; and communicated the same to one Jodocus Hondius, an engraver, who, contrary to his honest faith and engagement, published the same as his own invention: This occasioned Mr. Wright, in the year 1599, to exhibit his method of construction, in his book, intitled, *Correction of Errors in Navigation*; in the preface of which book may be seen his charge and proof against Hondius; and also how far Mercator has any right to share in the honour due for this great improvement in geography and navigation.

Blundevill, in his Exercises, page 327, published anno 1594, gives a table of meridional parts answering to even degrees, from  $1^{\circ}$  to  $80^{\circ}$  of latitude, with the sketch of a chart constructed therefrom; but this table he acknowledgeth to have received from Mr. Wright, in the following words, page 326, viz. "In the mean time to reform the saide faults," (in the plane chart) "Mercator hath in his universal " chard or mappe made the spaces of the parallels " of latitude to bee wider everie one than other " from the equinoctial towards either of the poles,

“ by what rule I know not, unless it be by such a  
 “ table as my friend Maister Wright of Caius-col-  
 “ lege in Cambridge at my request sent me (I thank  
 “ him) not long since for that purpose, which table  
 “ with his consent, I have plainlie set down,” &c.

About the year 1720, a globular chart was published, said to be constructed by Mr. Henry Wilfon; the errors in which were obviated by Mr. Thomas Hafelden, in a letter to Dr. Halley; who at the same time exhibited a new scale, whereby distances on a given course may be measured, or laid off, at one extent of the compasses, on Wright's projection; and was intended to render the same as easy in practice as the plane chart.

The above chart was published in opposition to Mr. Wright's, which that author charged with imperfections and errors, and that it represented places bigger than they are upon the globe.

It is true, the surface is apparently enlarged; but the position of places, in respect to one another, are in no wise distorted; and it may be asserted, with the same parity of reason, that the lines of fines, tangents, and secants, are false, because the degrees of the circle, which are equal among themselves, are thereupon represented unequal.

Yet if a map or chart was so constructed, as to shew the situation and true extent of countries, &c. *primâ facie* (if I may be allowed the expression), and yet retain all the properties, uses, and simplicity, of Wright's construction, it would be a truly great improvement; but this seems to be impossible.

The method exhibited by the Rev. Mr. Murdoch, in his paper, read before the Royal Society on the 9th of February last, shews the situation of places,  
 and

and seems better calculated for determining superficial and linear measures, than any other that has occurred to me.

This Gentleman illustrates his theory with examples justly intended to point out the quantity of error, that will happen in a large extent.

For instance; Between latitudes  $10^{\circ}$  and  $60^{\circ}$  N. and containing 110 degrees difference of longitude, Mr. Murdoch computes the distance at 5594 miles; which, upon the arc of a great circle, is found to be 5477, or by other methods 5462; so that the difference is only 117, or at most 132 miles in so great an extent, and to an high latitude; and the higher the latitude the greater the error is like to be, where-ever middle latitude is concerned.

His courses also agree very nearly with computations made from the tables of meridional parts.

In example the first they are the very same:

In example the 2d they agree to half a minute:

In example the 3d they vary  $1^{\circ} 4'$ , on account of the high latitudes, which extend from  $56^{\circ}$  to  $80^{\circ}$  N.

However, I do not esteem this method so simple, easy, and concise, in the practice of navigation, as Mr. Wright's construction, especially in determining the bearings or courses from place to place: nor will it (I presume) admit of a zone containing both north and south latitude.

Of these inconveniences Mr. Murdoch seems to be extremely well acquainted, when he expresses himself in the following very candid and ingenuous terms, *viz.* "As to Wright's or Mercator's nautical chart, it does not here fall under our consideration: it is perfect in its kind; and will always be reckoned among the chief inventions of the  
" last.



“ last age. If it has been misunderstood or misapplied by geographers, they only are to blame.”— And again, at the end of his nautical examples, he concludes thus, *viz.* “ It is not meant, however, that it ought to take place of the easier and better computation by a table of meridional parts.”

I have the honour to be, with the greatest respect,

S I R,

The ROYAL SOCIETY's, and

Your most obedient Servant,

William Mountaine.

ADDENDA to Mr. Murdoch's Paper, N°. LXXIII.

IF it is required “ to draw a map, in which the superficies of a given zone shall be equal to the zone on the sphere, while at the same time the projection from the center is strictly geometrical ;” Take  $Cx$  to  $CM$  as a geometrical mean between  $CM$  and  $Nn$ , is to the like mean between the cosine of the middle latitude, and twice the tangent of the semidifference of latitudes ; and project on the conic surface generated by  $xt$ . But here the degrees of latitude towards the middle will fall short of their just quantity, and at the extremities exceed it : which hurts the eye. Artists may use either rule : or, in most cases, they need only make  $Cx$  to  $CM$  as the arc  $ML$  is to its tangent, and finish the map ; either by a projection, or, as in the first method, by dividing that part of  $xt$  which is intercepted by the secants thro'  $L$  and  $l$ , into equal degrees of latitude.

Mr. Mountaine justly observes, “ that my rule does not admit of a zone containing N. and S. latitudes.” But the remedy is, to extend the lesser latitudes to an equality with the greater ; that the cone may be changed into a cylinder, and the rumbs into straight lines.

LXXV. *Cases of the remarkable Effects of Blisters in lessening the Quickness of the Pulse in Coughs, attended with Infarction of the Lungs and Fever: By Robert Whytt, M. D. F. R. S. Fellow of the Royal College of Physicians, and Professor of Medicine in the University of Edinburgh.*

Read Feb. 16.

1758.

ONE of the most natural effects of blistering plaisters, when applied to the human body, is to quicken the pulse, and increase the force of the circulation. This effect they produce, not only by means of the pain and inflammation they raise in the parts to which they are applied, but also because the finer particles of the *cantharides*, which enter the blood, render it more apt to stimulate the heart and vascular system.

The apprehension, that blisters must in every case accelerate the motion of the blood, seems to have been the reason, why some eminent physicians have been unwilling to use them in feverish and inflammatory disorders, till after the force of the disease was a good deal abated, and the pulse beginning to sink. However, an attentive observation of the effects, which follow the application of blisters in those diseases, will shew, that instead of increasing, they often remarkably lessen the frequency of the pulse. This I had occasion formerly to take notice

of (1), and shall now evince more fully by the following cases.

I. A widow lady, aged about 50, was seized (December 1755) with a bad cough, oppreſſion about her ſtomach and breaſt, and a pain in her right ſide, tho' not very acute. Her pulſe being quick, and ſkin hot, ſome blood was taken away, which was a good deal ſiſy: attenuating and expectorating medicines were alſo preſcribed. But as her complaints did not yield to theſe remedies, I was called on December 26th, after ſhe had been ill about ten days; at which time her pulſe beat from 96 to 100 times in a minute, but was not fuller than natural. I ordered her to loſe ſeven or eight ounces more of blood, which, like the former, was ſiſy; and next day, finding no abatement of her complaints, I adviſed a bliſter to be applied, in the evening, to that part of her right ſide which was pained. Next morning, when the bliſter was removed, the pain of her ſide was gone, and her pulſe beat only 88 times in a minute, and in two days more it came down to 78. However, after the bliſtered part became dry, the pulſe roſe in one day's time to 96, and continued between that number and 90 for four days; after which I ordered a large bliſter to be put between her ſhoulders. When this plaſter was taken off, her pulſe beat under 90 times in a minute; and next day it fell to 76, and the day after to 72. The cough and other ſymptoms, which were relieved by the firſt bliſter, were quite cured by the ſecond.

II. John Graham, bookbinder, in Edinburgh, aged 37, of a thin habit of body, formerly subject to coughs, and thought to be in danger of a *phthisis pulmonalis*, having exposed himself unwarily to cold in the night time, was, about the end of January 1756, seized with a bad cough and feverishness; for which he was bled, and had a diaphoretic julep, a pectoral decoction, and a mixture with *gum. ammoniacum* and *acetum scilliticum*, given him by Mr. James Russell, surgeon-apothecary in this place. On the 12th of February, after he had been ill above a fortnight, I was desired to visit him. He seemed to be a good deal emaciated; his eyes were hollow, and cheeks fallen in: he was almost constantly in a sweat; coughed frequently, and spit up a great quantity of tough phlegm, somewhat resembling *pus*: his pulse beat from 112 to 116 times in a minute. In this condition I ordered immediately a blister to be applied between his shoulders, which lessened in some degree his cough and spitting, as well as the frequency of his pulse; but the blistered part no sooner began to heal, than he became as ill as before, and continued in this bad way nine or ten days, gradually wasting, with continued sweats, and a great spitting of a thick *mucus*. During this time he used *tinctura rosarum*, and the mixture with *gum. ammon.* and *acet. scillit.* without any sensible benefit, and had six ounces of blood taken away, which was very watery, and the *crassamentum* was of a lax texture. In this almost desperate condition, another blister, larger than the former, was put between his shoulders, which remarkably lessened his cough and spitting, and in two or three days reduced his pulse to 96 strokes in a

minute. After this he continued to recover slowly, without the assistance of any other medicine, except the *tinctura rosarum* and the mixture with *gum. ammon.* and *acet. scillit.* and at present he enjoys good health.

III. Mrs. ———, aged upwards of 40; who had for several years been subject to a cough and spitting in the winter months, was, in October 1756, seized with those complaints in a much greater degree than usual; to remove which, she was blooded, and got some attenuating and pectoral medicines from Mr. John Balfour, surgeon-apothecary in Leith. I was called on November 11th, after she had been ill several weeks, and found her in a very unpromising condition. She had a frequent and severe cough, with great shortness of breath and a wheezing; her lungs seemed to be quite stuffed with phlegm, of which she spit a vast quantity every day, and of such an appearance, that I was apprehensive it was, in part at least, truly purulent. When she sat up in a chair, her pulse beat above 130 times in a minute. She had a considerable thirst, and her tongue was of a deep red colour, with a beginning aphthous crust on some parts of it. She was so weak, and her pulse so feeble, that there was no place for further bleeding: a blister was therefore applied to her back, November 11th, which somewhat lowered her pulse, and lessened the shortness of breathing and quantity of phlegm in her lungs. November 16th, a second blister was laid to her side, which gave her still more sensible relief than the former, and reduced her pulse to 114 strokes in a minute. November 25th, a third blister

blister was applied to her back · by which her cough and wheezing were rendered considerably easier, and the phlegm, which she spit up, lost its purulent appearance, became thinner, more frothy, and was much less in quantity. Her pulse beat now only 104 times in a minute. After this, her cough and spitting increasing again, she had, on the 20th of December, a fourth blister applied to her back, which, like the former, did her great service. Her stomach being extremely delicate, I scarce ordered any medicines for her all this time, except a cordial julep, with *spir. volat. ol. oj.* tincture of rhubarb as a laxative, and a julep of *aqu. rosar. acet. vin. alb.* and *syr. balsam.* of which last she took two table spoonfuls twice or thrice a day in a quarter of a pint of lint-seed tea. After the fourth blister, she drank for some time a cupful of *infusum amarum* twice a day, and continued to recover slowly : and tho' during the remaining part of the winter she was, as usually, a good deal troubled with a cough, yet in the spring she got free from it, and is now in her ordinary health.

IV. Christian M'ewen, aged 21, had laboured under a cough, thick spitting, pain of her breast, and pains in her sides affecting her breathing, for about a twelvemonth : and after getting, by proper remedies, in a good measure free from those complaints, her cough, from catching a fresh cold, increased to a greater degree than ever, became hard and dry, and was attended with a constant difficulty of breathing, pain in her left side, and head-ach. After having been seven or eight days in this condition, she was admitted into the Royal Infirmary, January

uary 9th, 1757. As her pulse was small, tho' very quick, viz. beating 130 in a minute, I thought it unnecessary to bleed her, as from former experience I did not doubt but that blistering alone would relieve her: I ordered, therefore, a large blister to be applied to her left side, where she complained of pain, and prescribed for her the following julep:

℞ *Aqu. menth. simp. spirit. Minderer. ana* ℥iij.  
*acet. scillit. ℥i. sacchar. alb. ℥ij. misce; cap.*  
*coch. ij. ter in die.*

She was also desired to breathe frequently over the steam of hot water, and to drink lintseed tea.

January 10th. Her pulse beat only 112 times in a minute, and was somewhat fuller than on the 9th. The blister was not removed till late in the evening, and made a plentiful discharge. The cough having been so severe last night, as to keep her from sleep, I ordered her the following anodyne draught:

℞ *Spirit. Minderer. ℥ss. acet. scillit. ℥i. syr. pappav. alb. ℥vi. misce; cap. bor. somni.*

Jan. 11th. The cough easier last night; difficulty of breathing less; pulse 108 in a minute. Ordered the anodyne draught to be repeated, and the use of the julep, with *acet. scillit.* to be continued.

Jan. 12th. Pulse slower; cough and pain of the side easier; but still complains of a head-ach.

Jan. 13th. Pulse 94 in a minute; cough continues easier in the night, but is troublesome in the day-time.

Jan. 14th. Every way better; pulse only 80 in a minute. As her cough is still bound, ordered her, besides the medicines above-mentioned, a pectoral decoction of *rad. alth. &c.*

Jan. 15th. Cough and other complaints in a great measure removed : pulse 65 in a minute.

From this time her cough gave her little trouble ; but on the 18th she complained of a pain in the *epigastrium*, with sickness at stomach, want of appetite, and a giddiness in her head, which were considerably relieved by a vomit, *infusum amarum*, and stomachic purges ; and were almost wholly cured by the return of her menses on the 5th of February, after an interval of eight weeks.

V. A girl 21 months old, who had (December 1756) a great load of the small-pox, and not of a good kind, with a cough and obstructed breathing, was, on the seventh day from the eruption, blistered on the back ; by which the pulse was lessened from 200 to 156 strokes in a minute. Next day her legs were also blistered, and the pulse thereby fell to 136. But the child's lungs being much oppressed, and her throat being so full of pustules that she could scarce swallow any thing, she died towards the end of the ninth day.

I could add several other cases of the remarkable effects of blisters in lessening the quickness of the pulse in coughs attended with fever, pain in the side, and pituitous infarction of the lungs : but those above may be sufficient to put this matter out of doubt, as well as to remove any prejudice, that may still remain against the free use of so efficacious a remedy.

In a true peripneumony, especially where the inflammation is great, repeated bleeding is the principal remedy, and blisters early applied are not so proper.



proper. But when the peripneumony is of a mixed kind; when the lungs are not so much inflamed as loaded with a pituitous matter; when bleeding gives but little relief; when the pulse, tho' quick, is small; when the patient is little able to bear evacuations, and the disease has continued for a considerable time; in all these cases blistering will produce remarkable good effects, and, far from increasing, will generally lessen the frequency of the pulse, and fever, more speedily than any other remedy.

On the other hand, when the fever and frequency of the pulse proceed from a true inflammation of the lungs, from large obstructions tending to suppuration, or from an open ulcer in them, blisters will be of less use, nay, sometimes will do harm, except in the last case, where they, 'as well as issues and setons, are often beneficial, tho' seldom able to compleat a cure. But as in pituitous infarctions of the lungs, with cough and fever, repeated blisters applied to the back and sides are far preferable to issues or setons, so these last seem most proper in an open ulcer of the lungs. The former make a greater and more sudden derivation, and are therefore adapted to acute cases; the latter act more slowly, but for a much longer time, and are therefore best suited to chronic diseases. Further, while blisters evacuate chiefly the serous humours, issues and setons generally discharge true purulent matter, and on this account may be of greatest service in internal ulcers.

In what manner blisters may lessen the fever and frequency of the pulse attending internal inflammations, I have elsewhere endeavoured to explain (2);

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(2) *Physiological Essays*, p. 69.

and shall only add here, that in the cases above recited, where the quick pulse and feverishness proceeded more from a pituitous infarction than a true inflammation of the lungs, blisters, by relieving this organ, in some measure, of the load of humours oppressing it, would render the circulation through its vessels freer, and consequently lessen the quickness of the pulse, and other feverish symptoms.

It may not, however, be improper briefly to point out the reason, why blisters, which have been observed to be remarkably efficacious, even when early applied, in pleurifies (3), are less so in true peripneumonies. This difference, I imagine, may be accounted for from there being no immediate communication between the pulmonary vessels and those of the sides and back, to which the blisters are applied; whereas the *pleura*, and intercostal muscles, are furnished with blood-vessels from the intercostal arteries, which also supply the teguments of the *thorax*: so that while a greater flow of serous humours, and also indeed of red blood, is derived into the vessels of the external parts, to which the vesicatories are applied, the force of the fluids in the vessels of the inflamed *pleura*, or intercostal muscles, must be considerably lessened. Further, as the intercostal muscles and *pleura* are, as well as the teguments of the *thorax*, supplied with nerves from the *true* intercostals, blisters applied to the back and sides may perhaps, on this account also, have a greater effect in relieving inflammations there than in the lungs,

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(3) Dr. Pringle's *Observations on the Diseases of the Army*, part iii. chap. 2.

which have nerves from the eighth pair, and from the *intercostals* improperly so called.

Edinburgh, May 23d, 1757.

*Extract of a Letter from Dr. Whytt, Professor of Medicine in the University of Edinburgh, and F. R. S. to Dr. Pringle, F. R. S.*

Edinburgh, 10 Nov. 1757.

WHAT you remark with regard to blisters being freely used by the physicians at London, in the cases mentioned in the paper I last sent you, is very just, and indeed what I knew; but altho' their efficacy in such circumstances is now generally acknowledged both in England and Scotland, yet I do not remember that their remarkable quality in lessening the quickness of the pulse has been particularly attended to. This, therefore, I thought it might not be amiss to ascertain by a few careful observations.

I agree intirely with you, as to the use of blisters in fevers; being of opinion, that when there is no particular part obstructed or inflamed, they are of little service, and sometimes hurtful, unless perhaps towards the end, when the pulse begins to sink. Nay, in fevers, where the substance of the brain is affected, and not its membranes, I have never found any sensible benefit from blisters: and I always suspect the brain itself affected, when a fever and delirium come on without any preceding head-ach, or redness in the *tunica albuginea* of the eyes. This kind of fever I have met with several times, and have observed it to be generally fatal.

LXXVI. *A remarkable Instance of Four rough Stones, that were discovered in an human urinary Bladder, contrary to the received Opinion; and successfully extracted by the lateral Method of Cutting for the Stone. By Mr. Joseph Warner, F. R. S. and Surgeon to Guy's-Hospital.*

Read Feb. 23.  
1758.

THE favourable reception those few papers have met with from the Royal Society, which I have done myself the honour of addressing to them, encourages me to take the liberty of offering the following account to their consideration: and I am the more immediately induced to submit this paper to their perusal, as the fact hereafter related may possibly be not esteemed a matter of mere curiosity; since it is probable, that the inferences deduced from the history of the subsequent case, when attended to, may prove of the greatest consequence to the future ease and welfare of the patient, as well as be a means of preventing the operator from falling into such errors, as cannot fail of drawing an imputation upon his character, in the practice of one of the most capital and difficult undertakings in his profession.

It is a maxim laid down by the most judicious and best received writers upon operations in surgery, that when the surface of a stone, which has been extracted from the bladder, appears to be totally rough, it amounts to a proof of its having been

there alone. But notwithstanding I admit it is from experience found, that the observation is in general well grounded, it may nevertheless appear, from the following case, that this rule is not unexceptionable : for which reason perhaps it may be thought right, that we should not be determined from circumstances only ; but, on the contrary, that it is necessary for every surgeon to take such methods during the operation, as will enable him to judge with that degree of certainty, without which he cannot be enabled to do so.

The methods I would recommend are these : That after the extraction of a stone from the bladder, tho' the whole of its surface be rough, the operator should nevertheless introduce the forefinger of his left or right hand thro' the wound into the cavity of the bladder ; by which means, if the subject be under twelve years of age, he will be enabled to come in contact with every internal part of the bladder with his finger : but if the subject be an adult, and of a corpulent habit of body, the finger, under these circumstances, not being found to be sufficiently long for the purpose, he must have recourse to a female catheter, or some other instrument that is nearly straight, quite smooth and polished, and of about nine or ten inches long ; which will serve the purpose equally well, if of a proper form and thickness. This is the method I have made use of upon the like occasions of late years, without giving any great degree of pain to the patient, or considerably retarding the operation.

Since I have had the opportunity of making the following observation, as well as a prior observation

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tion something similar to this, where two rough stones were extracted by me a few years ago from a young man's bladder of 15 years of age, I cannot help suspecting, that there may have been instances of one or more stones being left behind in the bladder at the time of operating, merely from the operator's putting too great a confidence in this general rule. Which suspicion I am led into from having known people, who have undergone the operation of cutting for the stone, relapse into the like disorder in a short time after the healing of their wounds, attended with such symptoms, as have obliged them to submit to a second operation; when the stone, upon being extracted, has appeared of so considerable a size, as to make it suspicious, that this stone must probably have been of a much longer growth, than the short time betwixt the two operations could admit of. The maxim laid down to us by authors, of a smooth and polished stone in the bladder being never there alone, but always accompanied with one or more stones of the same kind, I know no exception to. But if this phenomenon should ever occur, the strict observance of that rule (delivered to us by judicious writers in surgery) of always searching the bladder under the like appearances, on presumption of one or more stones being left behind, cannot be attended with any future mischief to the patient, when carefully executed by the methods recommended above, and undoubtedly should always be strictly attended to. The smooth and polished appearances of the surfaces of human *calculi* are universally supposed to arise from their rubbing one against the other; which may with reason be supposed

posed to be the case: but I confess this inference is not satisfactory to me; since it is probable, if this was the sole cause of their smoothness, the same effect would probably be always produced, when attended with the same degree of friction. But as this may be considered as a matter of mere speculation, I refer the decision of this point to those of superior abilities.

## C A S E.

Mr. William Woodhams, a gentleman farmer, of a corpulent habit of body, in the 46th year of his age, now living in the parish of Udimore, within three miles of Rye in Sussex, was attacked about eight years ago with severe complaints in his loins, accompanied with an incapacity of voiding his urine without the assistance of proper medicines, which were administered to him by a neighbouring apothecary for that purpose. These medicines had the desired effect: they promoted a secretion, and an evacuation of urine; which appeared to be loaded with a considerable quantity of gravelly particles mixed with a *mucus* of a whitish colour. In the space of three weeks he had perfectly recovered from this attack, and continued well for near five years afterwards, without any return of his complaint, except when he rode hard on horseback, or drank more freely of strong liquors than usual. At the expiration of five years he was seized with an acute fever, of which he recovered in a few weeks.

Very soon after his recovery from this illness, he began to complain of excessive pain in voiding his urine, or upon going to stool; which symptoms  
were

were so greatly increased for many months before he submitted to the operation, as to quite disable him from riding, from walking, or from using any kind of exercise. His urine, of late, was continually and involuntarily flowing from him in small quantities. He complained of great pain and foreness in his fundament, attended with a *tenesmus*. This account he delivered to me on the second day after the operation; and at the same time he very feelingly told me, that he had enjoyed but very few and short intervals of ease for the three last years, till since the operation.

On the 30th of January 1758, I cut him, at his own house in Suffex, having first prepared him for the operation in the manner, that is usual upon the like occasion. In the operation, I extracted the four stones, which I now have the honour of laying before the Royal Society. The whole surfaces of these stones appear to be rough, not having the least marks of ever having rubbed against each other during their confinement in the bladder: but yet I conjecture this must frequently have been the case, as there was no difficulty in embracing these *calculi* with the forceps: for had they been contained in different cells or pouches in the bladder, which sometimes have been observed from dissections, this circumstance would, in all probability, have rendered it impracticable for me to have so immediately got at them, if at all.

The forceps was introduced only three times into the bladder for effecting the extraction of the three first stones, and only twice for the extraction of the fourth stone. Besides these four stones, which I have presented to the Society for their inspection, I thought:  
it:



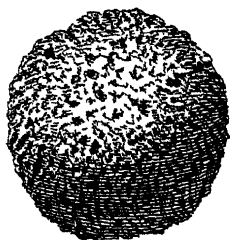
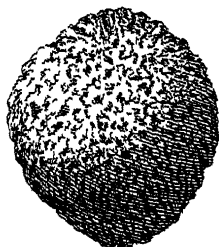
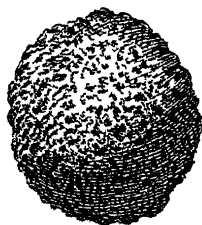
it not improper to produce, at the same time, some other human *calculi*, for their further satisfaction, each of which was found single in the urinary bladders of different subjects. The surfaces of these stones may be observed to be much smoother than the surface of either of the four stones, that were extracted from Mr. Woodhams's bladder in the operation I have just now recited; and therefore it was more reasonable to expect to find each of these stones accompanied with one or more stones in the same bladder (according to the received opinion), than it was to find more stones than one in the case of Mr. Woodhams's, which has given rise to these observations.

But as the fact before us does of itself shew the impropriety and danger of determining from the surfaces of such extraneous bodies, perhaps it may be thought needless to enlarge upon this subject, to strengthen those precautions so reasonable to be observed in this operation. However, as I have already taken notice of the smooth and polished appearances of the surfaces of such stones, as are probably never found single in the bladder; I have produced two stones of this kind, that were extracted from the same bladder, to shew, that these stones do no more resemble those stones of Mr. Woodhams's, than a piece of polished marble can be said to resemble a rough block of the same species.

P. S. I am informed, by a letter from Suffex, dated the 18th instant, that Mr. Woodhams is perfectly well in health; that the whole of his urine had passed through the urethra for the last







*This Plate is an exact representation of the Sizes and external appearances  
of the four rough Stones described in the preceding paper*



last five or six days; and that his wound will, in all probability, be soon healed.

Hatton-Garden,  
February 22. 1758.

Joseph Warner.

LXXVII. *Observations on the Limax non cochleata Purpur ferens, The naked Snail producing Purple.* By John Andrew Peyssonel, M. D. F. R. S. Translated from the French.

Read Feb. 23,  
1758.

**A**MONG the fish we meet with in the seas of the Antilles of America, we find, that this I am going to describe will appear precious, from the beautiful purple colour it produces, in the same manner, that the cuttle-fish produces its ink, if a means could be found to procure this liquor in a sufficient quantity to render it an article of commerce. These fishes are soft, viscous, without shells, scales, or bones; are of the nature of the *polypi*, and such other kinds, without feet, fins, or any thing to supply their places. Their motion is vermicular; and, like the slugs, they wreath themselves up, and when touched make themselves quite round.

They fill up certain membranes of the body with water. Their local motion; *antennæ*, which they lengthen and contract; and a great many other properties, which they have in common with snails, slugs, and turbinated shell-fish, made me call them naked snails: and altho' they have not the most es-

essential qualities of snails, I thought I might give them the name; for they have no particular appellation in this country. Some call them pifs-a beds, some sea-cats, and others a less modest name, *tapecon*, taken from Pliny. The Negroes and country people disagree upon this subject; and therefore I thought all their names ought to be rejected, in order to adopt a more significant one, which I have given them; and that altho' they are without shells, a quality essential to snails, they had a right to that class by their other properties and qualities.

This fish is commonly four inches long, and two thick; of a greenish colour spotted with black, each of which forms a circle. The under part is like that of snails, flat, with kinds of *mamillæ*, or rugosities, which are adhesive; by means of which they advance in a vermicular motion; and when touched become round, by retracting their neck and head; and afterwards protrude them considerably, according to their motion and progression, crawling upon rocks to seek their food.

The head of this animal has a flatness, or is inclinable to a square or parallelogram. On each side there are membranes or skins, which form kinds of ears; and under them others, which at times fill with water, and are then transparent. Under this thick skin there is a *cranium*, of a kind of coriaceous or cartilaginous matter; and in the *cranium* we find the brain, which is a white substance, and very firm. At the basis of the head its oval wide mouth is placed, being above two lines long, which often discovers a white hard edge, with which he crops the fucus's, and other sea-plants, for his nourishment.

About half an inch from the ears there are two  
horns,

horns, or *antennæ*, like those of some testaceous animals, which serve them for eyes; and these *antennæ* extend and contract at will, turning to either side also. The *oesophagus* begins at the upper and inner part of the mouth, which is a delicate long tube; near which there is another thick one, and made nearly like the colon, which leads to a bag, or the first stomach, which may be likened to the craw of a fowl: it is always filled with fucus mixed with sand. Sometimes this stomach is double, or at least lengthens itself considerably, and the aliment parts it, as it were, into two portions. After this craw, or stomach, we find another, which performs the same office with the gizzard of fowls. The membranes are thick, and are set with twelve stones, or horny pieces, of a bright yellow colour, and as transparent as fine yellow amber, ending in points like a diamond; so that the great side, or basis, is set into the membrane of the gizzard as a diamond in its socket: others differ in size, having different figures, that in acting all together they may be able to break and grind the herbs the animal feeds upon, as well by the strength of the muscle or gizzard, which puts them into action, as by the situation of these stones, assisted by grains of sand found in it, turning the whole by this trituration into a liquor. Afterwards, what was thus triturated by the power of the gizzard passes into a third belly or stomach, which is covered by a purple body, resembling the *parenchyma* of the liver, and nearly of the same consistence: then this belly turns into a long tube, which surrounds this *parenchyma*, and is covered in like manner by a very fine membrane: it is full of a white liquor, like chyle, and goes to discharge itself into another refer-



voir, at the side of which is a yellowish gland, like a *pancreas*. From these two bodies or glands, one of which may be called hepatic, and the other pancreatic, two conduits pass out; that of the *pancreas* is white, the other of a blackish purple: the first conducts its chyle, condensed, into a reservoir or bladder, which may be resembled to the *receptaculum chyli* of Pequet, and from thence passes to the fecal matter: the other conducts to a body made like the mesentery, but which is always found out of the common capacity or cavity, in which all the *viscera* are contained; which I thus describe:

This common capacity is very large, beginning at the head and ending at the tail of the fish: it is sometimes filled with a yellowish water, and is formed by the fleshy body of the animal; which is only a membrane composed of fibres every way interwoven together, open at the top, where the organs are situated, which contain the purple juice.

There is a hollow upon the back of the animal, where the canal, filled with a reddish juice, passes out, carrying it to a fringed body like a mesentery; and it is there the purple juice is brought to perfection; and afterwards goes to a long sack lying under a kind of horny plate, not like the bone of the cuttle-fish, but like the bone of the *sepia*, or little cuttle-fish, which we call *le couteau*. This bone, or horny substance, is transparent; and is of a triangular figure, or approaching the form of a bivalve shell. On the right side it is fastened by a strong cartilaginous muscle, which binds it to the body of the animal; and on the left it is open and detached, and easy to be pulled up: then it is easy to see underneath both the mesenteric body, and the tube or reservoir of the purple

ple juice. This bone, or horny plate, is covered by a loose membrane, which is by no means attached to it, but capable of being filled and inflated with water or wind.

The whole is covered with two membranes, which are continuations of the flesh of the fish's body: the membranes are loose, and larger than are necessary to the bone: they are wrinkled or rumpled over one another, to cover the whole, and to defend the bone and *viscera* from all kinds of pressure; but they are ready to stretch one from the other, and leave the parts destined for the purple juice uncovered. They begin a little under the neck, and extend, in the female animal, to the tail, which is flat; and in the male they do not go so low, but end at some distance from the tail.

The females are oviparous; for eggs are found in the grand cavity, at the side of the pancreatic body.

I have already said, that when the animal is touched, he makes himself round, and throws out his purple juice, as the cuttle-fish does his ink. This juice is of a beautiful deep colour: it tinges linen, and the tincture is difficult to get out. It remains at present to try if we can collect a sufficient quantity of this juice, and to find a means of preserving the tincture; which would then be certainly of great value: to which purpose I may apply myself.

When the fish is boiled, or put into spirits, it shrinks up, and loses two thirds of its size; because all the water, which is in the interstices of the fibres, is dissipated, and the dried fibres contract: which clearly appears from dissecting them.

Dated at Gua'alupe,  
26 Mar. 1757.

Peyssonel.  
LXXVIII.

LXXVIII. *New Observations upon the Worms that form Sponges.* By John Andrew Peyssonel, M D. F. R. S. Translated from the French.

Read Feb. 23. 1758. **T**HE existence of the nests of corallines and lithophyta, and the mechanism of their polypi, made me conjecture, that it was the same with respect to sponges; that animals, nested in the interstices of their fibres, gave them their origin and growth: but I had not yet seen nor discovered the insects, nor observed their work. Sponges appeared to me only as skeletons: but I at length discovered these worms, which form sponges, in the four following species:

1. *Spongia Americana tubo similis*; The tube-like sponge of Plumier.
2. *Spongia Americana longissima funiculo similis*; The cord-like sponge of Plumier.
3. *Spongia Americana capitata et digitata*; The fingered sponge of Plumier.
4. *Spongia Americana favo similis*; The honey-comb sponge of Plumier.

These four kinds only differ in form: they have the same qualities, are made by the same kinds of worm, and what may be said of the one agrees exactly with all the rest; for I made the same observations upon them all.

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They may be classed among the *spongiæ lycina*, so called by J. Bauhin, because of the roughness of their fibres, by a metaphor, from pieces covered with mud; or among those called by Pliny *tæges*, or *aplysæ*, being foul, and difficult to cleanse; and may take the name, which Father Plummer has given them, drawn from their figure.

These four kinds of sponges are composed of hard, firm, dirty fibres, sometimes brittle; separated one from another, having large hollow, or cylindrical tubes, dispersed thro' their substance. These tubes are smooth within. The interstices of their fibres are filled with a mucilaginous gluey matter, when the sponge is just taken out of the sea. The mucilage is of a blackish colour, soon putrifies in the water, or falls into dust when dried in the sun.

When a fresh sponge is squeezed this mucilage comes out frothy, by the mixture of the windings of its fibres: it always issues forth with sand, or little parcels of shells crushed by the sea. These fibres, which consist of the twisted doubles of the sponge, form as it were a labyrinth filled with worms, which are easily crushed, and their juice is confused with the mucilage; but having carefully torn the sponges, and their gross fibres, I discovered the living worms, such as I shall mention hereafter.

These species of sponge commonly grow upon sandy bottoms. At their origins we perceive, as it were, a nodule of sand, or other matter, almost petrified, round which the worms begin to work, and round which they retire, as to their last seat or refuge; where I had the pleasure of seeing them play, exercise themselves, and retire, by examining them with  
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the microscope; and I have even made my observations without its assistance.

*A Description of the Worms which form the Sponges.*

The worms I found in these kinds of sponges are about one-third of a line thick, and two or three lines in length. They are so transparent, that one may discern their *viscera* thro' their coverings and substance: the blood may be seen to circulate, and all their parts to act. They have a conic figure, with a small black head furnished with two pincers: the other extremity is almost square, and much larger than the head. Upon the back may be seen two white streaks or fillets, as if they contained the chyle: these two canals are parallel to each other from the head to the other extremity, where they come together. In the middle, where the belly and *viscera* ought to be placed, a blackish matter is perceivable, which has a kind of circulation: sometimes it fills all the body of the worm, sometimes it gathers towards the head, or at the other end, and sometimes it follows the motion of the animal. This vermicular motion or progression begins at the posterior extremity, and ends at the head, which is pushed, and consequently advances forward. I kept these worms alive out of the sponge, quite detached from it, more than an hour, having examined them thoroughly with a middling magnifier; for a great magnifier would be the grave of the insect.

I was surpris'd, after having finish'd my observations when I put them near a piece of the fresh sponge, where the nests were moist, and from which  
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I had pulled them, to see them enter into them, and disappear, being lost in the windings of the tubes. I thought to have found them again ; but it was a difficult task to search for them. I crushed them, or they were themselves mashed in the tubes, which I pressed, and of which I had consequently spoiled the texture ; but I could not find them ; and this happened several times.

These worms have no particular lodge : they walk indifferently into the tubular labyrinth. So that, without offence to Pliny and other naturalists, I do not see, that it is in their power to dilate and contract the bodies of the sponges ; which always remain in the same state of magnitude, without being any way sensible to the touch, or any other motion of the sea, nor to any other accident whatsoever, being an inanimate body ; for the animal sensitive life, or whatever you will have it, belongs only to the worms, that form these bodies, and which are their dwelling-places ; and which, by the slaver or juice they deposit, make the sponge increase or grow, as bees, wasps, and especially the wood-lice of America, increase their nests or cells.

These sponges, nests, or cells, are attached to some solid body in the sea. Some kinds are fixed to rocks ; others, as those I am speaking of, are fastened to heaps of sand, or to pieces of petrified matter, and even upon sandy bottoms ; and the sea putting in motion the sand, and the little parcels of broken shells, forces them into the holes of the sponge : there the sand binds and mixes with mucilaginous juice, and never is loosed from it but when the sponge is well dried, or with the mucilage when

putrified, or in powder; and yet some part will remain, which it is very difficult to take out from the twisted canals, especially in those sponges of the *tragos* kind, so hard to cleanse. In a word, the blood or humours, which the ancients have observed, is no other than the mucilage or juice of the substance of these worms.

Dated at Guadaloupe,  
1 March, 1757.

**LXXIX.** *Account of an Experiment, by which it appears, that Salt of Steel does not enter the Lacteal Vessels; with Remarks. In a Letter to the Rev. Tho. Birch, D.D. Secr. R. S. By Edward Wright, M. D.*

S I R,

Read Mar. 2,  
1758.

**T**H O' iron is universally allowed to be one of the most powerful medicines now in use, yet many physicians observing, that the *fæces* of patients, who used it either in a metallic or saline form, were tinged of a black colour, have been led to think, that, in a metallic state, it could not be reduced into particles fine enough to be received by the lacteal vessels; and if taken in a saline form, that it underwent a precipitation in the intestines, by which, being reduced to an earth or calx, it was in like manner rendered incapable of making its way into the blood. But the accurate experiments, with which Signor Menghini has favoured  
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the public in the Memoirs of the Bononian Academy \*, sufficiently prove, that the ore and filings of iron, finely levigated, enter the blood in considerable quantity; as does also the *crocus, calx*, or earthy part of the metal, tho' in less proportion than the two former, which were found to act with a violent *stimulus* on the vessels, and to have dissolved and broke the *crasis* of the blood of different animals, that had used them for some weeks in large doses mixed with their ordinary food. Tho' it must be allowed, that these experiments are very curious, yet the subject seems to require a further inquiry, viz. *Whether iron is capable of entering the blood in a state of solution, or under a saline form*: for, from the violent *stimulus*, as well as from the dissolution of the blood, and other symptoms brought on by the use of the ore and filings, these substances (not being properly dissolved) appear to have acted in a manner so grossly mechanical, that, whatever Signor Menghini may think, very little is to be concluded from them, with regard to the action of iron on the human body, in such cases, as indicate its use, and where a rational physician would think proper to prescribe it as a medicine.

Having read Signor Menghini's memoir, I recollected, that in the year 1753 I had, with the assistance of two friends, made the following experiment, in order to discover, whether iron, in a saline form, is capable of entering the lacteals.

An ounce and a half of salt of steel dissolved in a sufficient quantity of water, filtrated and mixed with

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\* Vincentius Menghinus *de Ferrearum particularum progressu in Sanguinem. Comment. Acad. Bonon.*, T. II. P. 2. pag. 475.



about a pound of bread and milk, were forced down the throat of a dog, that had been kept fasting for 36 hours. An hour after he had swallowed this mixture, having secured him in a supine posture, as is usual in such experiments, we opened the abdomen, and observed the lacteal vessels, like white threads, running along the mesentery in a very beautiful manner. Upon flitting open part of the small guts, we there found a good deal of the mixture, which appeared frothy, but without any black colour, or the least sign of the salt being precipitated; and struck a deep inky colour with infusion of galls. Tho' the white colour of the lacteals convinced us, that they were full of chyle, yet, as it would have been impossible to have collected a sufficient quantity of it from them, we found it necessary to open the thorax, and tie the thoracic duct a little above the receptacle, which, from the ligature, soon became turgid, the animal being alive and warm, and the chyle still continuing its course towards the thoracic duct. Having cut open the receptacle, we easily collected a sufficient quantity of chyle, and immediately mixed therewith, drop by drop, infusion of galls; a very simple and easy method, by which an incredibly small quantity of salt of steel may be discovered in most liquors: but not the smallest change of colour was observed, tho' they were rubbed together for some time, and allowed to stand several hours. Now had there been a single atom (so to speak) of the salt in so small a portion of chyle, as that used in this experiment, which was, as near as I could guess, somewhat less than half an ounce, it is not to be imagined, that it could have failed to  
discover

discover itself by this method of trial; for upon adding one fourth of a grain of the salt, this mixture instantly became of a bright purple: and I have found, by other experiments, that the smallest quantity of salt of steel shews itself as ready in the chyle by galls, as in any other liquor of the same consistence.

This experiment (which was as fair as could have been desired), together with another observation I have made, *viz.* that neither the blood nor urine of patients, during the use of salt of steel, in the least change colour with galls, renders it more than probable, that this salt *does not enter the blood.*

As the salt was found to have undergone no change in the small guts, it appears, that it is not prevented from entering the lacteals by its being decomposed or precipitated, as has been imagined; but, on the contrary, that what renders it incapable of being received by these vessels, is its *astringency*: for the lacteals seem to be endowed with that admirable faculty of admitting such particles of pure chyle as they happen to be in contact with, and of accommodating their diameters to them, at the same time that by their natural irritability, and power of constriction they obstinately exclude such as are astringent; which, were they to enter the lacteals, would either produce dangerous obstructions in these vessels, or, if they got into the blood, would occasion polypous concretions in the larger vessels, or coagulations incapable of being transmitted thro' the minute vessels of the lungs; the effects of which would be either sudden death, or at least inflammations and suppurations from obstructions in the pulmonary vessels; inconveniences,  
which

which nature, by precluding astringents from entering the lacteals, has carefully and wisely avoided.

Salt of steel, taken internally, must retain its astringency until it be precipitated; which can scarce ever fail to happen in the great guts, from the putrid *feces* they contain, which are always observed to be tinged of a black colour from the metallic basis of the salt, part of which, as it has little or no astringency, may, no doubt, enter the blood, as Signor Menghini observed of the *crocus*, which is the same substance; and we know, from the experiments of Lister and Musgrave †, that particles much grosser than those of the white chyle, provided they be not astringent, or very acrid, are conveyed by the lacteals. But the metallic basis being separated from its acid, and thus reduced to a mere calx or earth, can scarce be supposed to have any medicinal quality whatsoever, or at least to have any share in the virtues justly attributed to salt of steel.

As this salt is not only astringent, and consequently a strengthener, but at the same time acts with a gentle *stimulus*, all its virtues (which are known to be very great in diseases, where the fluids are either viscid, cold, and phlegmatic, or dissolved and watery, from a laxity of the solids) may be accounted for from its immediate effects on the stomach and *primæ viæ*, and on the system of the solids in general by consent; which it would be needless to illustrate by similar examples, because well known to every one the least versed in medical studies. I shall therefore only beg

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† Phil. Transact. by Lowthorpe, vol. iii. p. 102. edit. 1749.  
the same by Jones, vol. v. p. 259.

leave, from the obvious qualities of this medicine, and from what has been observed above, to deduce the following corollaries.

1. That salt of steel has no deobstruent or aperient virtue by any immediate action, that it can possibly have on the blood, or other animal fluids, as some have imagined; but that, on the contrary, it owes this quality to its *not entering the blood*, which it would otherwise coagulate, and to its *action on the solids alone*.

2. That in diseases proceeding from a laxity of the solids, great care ought to be taken to restore and invigorate the *primæ viæ*; since a medicine (and this we may presume not the only one) whose immediate action is confined to those parts, is yet found by experience to produce so salutary effects in such diseases.

3. That as this salt does not enter the blood, and consequently cannot be in danger of too much stimulating or constricting the vessels, on which it only acts by consent, it may, in small doses, be successfully used in many cases, where it has been imagined to be hurtful, particularly in consumptions of the lungs, so frequent and fatal in this island; which are commonly attended with too great a laxity of the *primæ viæ*, and of the solids in general, tho' they seem more immediately to proceed from a laxity and weakness of the pulmonary vessels; in which circumstances it must be of the utmost consequence to restore the tone of those principal organs of chylification, the *primæ viæ*; as good chyle not only corrects the acrimony of the blood, which in the advanced stages of consumptions so much prevails, but likewise saves  
a great

a great deal of labour, which the lungs (already too much oppressed) must otherwise undergo from a crude and ill-concocted chyle. Agreeably to this we find, in the *Essays Physical and Literary* of Edinburgh \*, two well-vouched histories of patients far gone in consumptions, with the usual symptoms of pain in the breast, cough, gross spitting of fetid matter, difficulty of breathing, hectic fits, and morning sweats, perfectly cured in a few weeks, by the use of the Hartfell-Spaw near Moffat; which, contrary to what is observed in most natural chalybeate waters, contains a fixed vitriol of iron.

These, Sir, are the few observations I had to make at present on this subject. I have taken the liberty to address them to you, in order, if you shall think proper, to be communicated to your illustrious Society; which, I hope, will continue to latest posterity those interesting researches for the advancement of every branch of natural knowledge, by which it has already acquired so much and so deserved honour; and am, with the greatest respect,

S I R,

Your most obedient humble Servant,

Strand, Feb. 28. 1758.

Edward Wright.

\* Vol. I. art. xii. p. 364.

LXXX. *A Dissertation on the Antiquity of  
Glass in Windows. In a Letter to the  
Rev. Tho. Birch, D. D. Secret. R. S. By  
the Rev. John Nixon, M. A. F. R. S.*

Dear Sir,

London, March 2. 1758.

Read Mar. 2, 1758. **I** Had the honour last winter to lay before the Royal Society a few observations upon some of the curiosities found at Herculaneum, &c. (1). Among other articles, I just mentioned a piece of a plate of white glass; and now beg leave to inquire into the uses, to which such plates might be applied in the early age, to which this fragment undoubtedly belongs.

And here a person, who forms his ideas of ancient customs by what he sees practised in later times, may be ready to offer several conjectures; in some of which he will, probably, be mistaken; as in others he may be justified by the genuine evidences of antiquity.

And, first, It is obvious to imagine, that such plates might serve for *specula*, or looking-glasses. And, indeed, that *specula* were anciently made, not only of metals, and some stones, as the (2) phengites, &c. but also of glass, may, I think, be collected from Pliny, who, having mentioned the city of Si-

(1) In a paper read Feb. 24. 1757. See Art. xiii. p. 88.

(2) *Porticum, in quibus spatium consueverat (Domitianus) parietes phengite lapide distinxit, e cujus splendore per imagines quicquid a tergo fieret, provideret.* Sueton. Domit. c. 14.

don as formerly famous for glass-houses, adds immediately afterwards, *Siquidem etiam specula excogitaverat* (3). But then it is to be observed, that before the application of quicksilver in the constructing of these glasses (which, I presume, is of no great antiquity), the reflection of images by such *specula* must have been effected by their being besmeared *behind*, or tinged *thro'* with some dark colour, especially black, which would obstruct the refraction of the rays of light (4). Upon these hypotheses (supposing the tincture to be given after fusion) the *lamina* before us may be allowed to be capable of answering the purpose here assigned.

It may further be suggested, that plates of this kind might be intended to be wrought into lens's, or convex glasses, either for burning, or magnifying objects placed in their focus. But this designation cannot be supported by proper vouchers from antiquity. On the contrary, we are informed, that the ancients used either *specula* (5) of metal, or balls (6) of glass for

(3) Plin. Nat. Hist. lib. xxxvi. c. 26. §. 66.

(4) Pliny mentions a kind of glass or jet called *obsidianum* :—*nigerrimi coloris, aliquando et translucenti, crassiore visu, atque in speculis parietum pro imagine umbras reddente.* Nat. Hist. lib. xxxvi. c. 26. §. 67.

And that the practice of staining glass was known in his time, appears from what he says concerning the *obsidianum* mentioned above :—*Fit et genere tincturæ—totum rubens vitrum, atque non translucentum.* Ibid.

(5) Panciroll. Rer. Mem. p. 288.

(6) These glass balls had sometimes water within them : *Cum additâ aquâ vitreæ pilæ sole adverso in tantum exardebant, ut vestes exurant.* Plin. lib. xxxvi. c. 22. §. 45.

for the former of these purposes; as it is well known, that glass was not applied to the latter, in optical uses, till the beginning of the XIIIth century (7).

However, we may with greater probability propose another use, for which the ancients might employ such plates of glass, as are now under consideration, *viz.* the adorning the walls of their apartments by way of wainscot. This I take to be the meaning of the *vitrea camera* mentioned by Pliny (8); who intimates, that this fashion took its rise from glass being used by M. Scaurus (9) for embellishing the scene of that magnificent theatre, which he erected for exhibiting shows to the Roman people in his ædileship (10). And we may collect from the same author (11) (what is further confirmed by his contemporary (12) Seneca), that this kind of ornament had

*Invenio medicos, quæ sunt urenda corporum, non aliter utilius id fieri putare, quam crystallinâ pilâ adversis positâ solis radiis.* Plin. Nat. Hist. lib. xxxvii. c. 6. §. 10.

(7) Vid. Monf. Renaudot Memoires de l'Acad. des Inscript. tom. I.

(8) Vid. infra, not. II.

(9) *Theatrum Scauri* — *scena ei triplex in altitudinem cccclx columnarum.* — *Ima pars scenæ e marmore fuit: media e vitro: summa e tabulis inauratis.* Nat. Hist. lib. xxxvi. c. 15.

(10) A. V. 678. Hard. not. Plin. lib. xxxvi. c. 8.

(11) *Agrippa in thermis, quas Romæ fecit, figlinum opus encausto pinxit, in reliquis albaria adornavit: non dubiè vitreas facturum cameras, si prius inventum id fuisset, aut a parietibus scenæ — Scauri pervenisset in cameras.* Lib. xxxvi. c. 25. §. 64.

(12) Seneca, exposing the luxury of the Romans with regard to their baths, says, *Pauper sibi videtur ac sordidus, nisi parietes magnis ac pretiosis orbibus refulserint — nisi vitro absconditur camera.* — Ep. 86.



been admitted, in his time, into chambers in houses, baths, &c. Whether the plates used for this purpose were stained with various colours (as mentioned above), or had tints of divers kinds applied to the back part of them, I shall not pretend to determine: but in either way they would have a very agreeable effect.

The last destination, which the obvious congruity of the thing itself, countenanced by the practice of many ages past, as well as of the present time, would induce one to ascribe to such plates of glass, is that of windows for houses, baths, portico's, &c. But I am sensible, that whoever should be hardy enough to advance such an hypothesis, would be censured as an innovator, in opposing the general opinion of the connoisseurs in antiquity. These gentlemen are almost unanimous in asserting, that whenever we meet with mention made of *specularia* in ancient writers (especially those of, or near to, the age, to which we must refer this fragment), we are to understand by that term nothing but fences made of *laminæ*, either of a certain stone called from its transparent quality *lapis specularis* (13), brought first from Hispania Citerior, and afterwards found in Cyprus, Cappadocia, Sicily, and Africa; or of another stone of the same nature, *viz.* the phengites. These, tho' expressly distinguished from each other by Pliny (14), are yet reckoned by some moderns (15) as one and

(13) Plin. Nat. Hist. lib. xxxvi. c. 22. §. 45.

(14) Nat. Hist. lib. xxxvi. c. 22. §. 45.

(15) Vid. Salmassius in a passage to be produced hereafter.

the same thing; and thought to have been nothing but a kind of white transparent talc, of which (according to Monf. (16) Valois) there is found a great quantity in Moscovy at this day.

Now that this *lapis specularis*, or phengites, was really used for windows by the ancient Romans in their houses, &c. cannot be denied; since (according to the opinion of the learned (17) in antiquity) this usage is mentioned by Seneca (18) among other improvements in luxury introduced in his time. But whether it was so used exclusive of other materials (particularly glass), may, I think, admit a doubt. Salmasius is of opinion (19), that nothing can be determined upon this point from the word *specular* itself, which seems to be a generical term, equally applicable to windows of all kinds, whether consisting of the *lapis specularis*, or any other transparent substance.

And as (according to this learned writer) there is nothing in the term *specular* itself, which hinders it from being extended to windows made of other ma-

(16) Hist. de l'Acad. des Inscrit. tom. I.

(17) Monfauc. Antiq. vol. III. part i. lib. iii. c. 4. Lipsius in loc. &c.

(18) *Quædam nostrâ demum prodisse memoriâ scimus; ut speculariorum æm, perlucens testâ, clarum transmittentium lumen.* Sen. ep. 90.

(19) *Quod fenestris obducebatur ad translucentum, ac lucem admittendam specular vetens Latini vocârunt. Idque ex speculari lapide, qui est ορυζιτης, aut ex vitro fiebat, aut aliâ translucentâ materiâ. Nam specular dictum, non quod ex speculari lapide factum esset, sed quod visum transmitteret, ac per id speculari liceret.* Salm. Exerc. Plin. in Solin. tom. II. p. 771.

think believe those above-mentioned; so others imagine, that there are some intimations in ancient authors, which require, that it should actually be so extended. Thus Mr. Castells, the ingenious illustrator of the villa's of the ancients, thinks (20), that "if this had not been the case, Palladius would not have given directions to his husbandman to make "*specularia* in the *olearium* (21), or store-room, "where the olives were preserved. For it appears " (says this author) from Pliny's describing a temple (22) built of the *lapis specularis*, or phengites, "as the greatest rarity in his time, and the mention Plutarch makes of a room in Domitian's palace "lined with it, that it was not common enough "for husbandmen to purchase;" viz. in such quantities, as were required for the purposes mentioned above.

I shall not take upon me to decide upon the weight of this argument of Mr. Castells; but only observe, that if any one should be induced by it to think, that the use of glass for windows may be of much greater antiquity than is commonly allowed, or even as old as the fragment, which occasions these remarks, he may find other probable reasons to corroborate his opinion. As, first, that there seems to have been a natural and obvious transition from the practice of

(20) Villa's of the Anc. illustrated, p. iv.

(21) One of Pliny's cautions for preserving apples is — *Aufros specularibus arcere*. Nat. Hist. lib. xv. c. 16.

Martial further informs us, that the Romans used to screen their orchards of choice fruit trees with *specularia*. Lib. viii. epig. 14.

(22) I suppose he means that of Fortuna Seia. Lib. xxxvi. c. 22.

using

using glass plates for the ornamenting the walls of apartments to that of introducing light into those apartments, (as we find the *lapis specularis* was in fact employed at the same time for both those purposes) and consequently it seems reasonable to suppose, that the latter of these applications could not be long in point of time after the former. But it appears from the authorities produced above, that the former of these usages did actually subsist in the age (23) of Pliny; and therefore before the destruction of Herculaneum, where he lost his life (24). From whence we may draw no improbable conclusion, that the latter destination of plates of glass, (*viz.* for window-fences) did likewise precede the same event.

Give me leave to add further, that this presumptive argument in favour of the antiquity of windows made of plates of glass receives an additional force from the close relation, which must be allowed to subsist between them, and those composed of the *lapis specularis*. The former must be looked upon as an improvement upon the other, as they answered

(23) Salmasius, speaking of the custom of adorning chambers with glass, says—*Quod proximè ætatem suam incepisse fieri narrat Plinius. Quum M. Scaurus*— Ex. Plin. tom. II. p. 854.

I do not find this expressly asserted by Pliny: but it might have been so in fact. This fashion indeed was not begun till after Agrippa had built his *thermæ*: but if we suppose that to have been even as late as his third consulship, *viz. ante Christi. 27.* (*Helveticus*), when he erected the Pantheon (or at least its portico), near adjoining to those *thermæ*, there would have been sufficient room, from that period to the birth of Pliny (*viz. anno Christi 24.*), for the introduction of this usage.

(24) Plin. Ep. V. l. III.

all the purposes of convenience, and at the same time were more beautiful; and being the manufacture (25) of Italy, might probably be purchased at a less expence. Upon all which accounts it seems reasonable to conclude, that one of these inventions would naturally be introductory to the other: and consequently, that as window-lights of the *lapis specularis* began to be used within the memory of Seneca, who died (26) under Nero, about *anno Christi* 68. (*Helvic.*), the original of those of glass may have fair pretensions to a place within the period assigned in the foregoing paragraph, *viz.* some years before the destruction (27) of Herculaneum, in whose ruins the plate before us was buried.

To conclude: I need not observe to you, that all the evidence here produced to prove the usage of glass-windows to have been coæval with the fragment we are now considering, is of the conjectural kind only: for, I must confess, I have not been able to trace it up by any positive authority higher than about 200 years short of the epocha last mentioned, *viz.* to the latter end of the third century (28), when it is expressly mentioned by Lactantius in these words: — *Manifestius est, mentem esse, quæ per oculos ea,*  
*quæ*

(25) Plin. Nat. Hist. lib. xxxvi. c. 26. §. 66.

(26) Vid. *supra*.

(27) Anno Christi 80.

(28) In order to justify my placing the testimony of this Father so high, I would observe, that St. Jerome (*De Scriptor. Eccles.*) says, that Lactantius—*Extremâ senectute magister Cæsaris Crispi f.ii Constantini in Galliâ fuit.* He must probably have exercised this

*quæ sunt opposita, transpiciunt, ut si per fenestras lucente vitre a. t. siculari, tunc d. n. f. c. — De opificio Dei, cap. v.*

I am,

S I R,

Your most obedient humble Servant,

J. Nixon.

**LXXXI.** *An Account of an extraordinary Case of the Efficacy of the Bark in the Delirium of a Fever.* By Nic<sup>s</sup>. Munckley, M. D. Physician to Guy's-Hospital, and F. R. S.

Read April 6.  
1758.

**A**S the following case contains some circumstances, which are curious in themselves, and which may be of service to be known, I have thought it proper to be laid before the Society.

this charge between *anno Chrijii* 309, when Constantine began to reign, and 320. If he was then of a great age, he might have composed the treatise, out of which this authority is produced, and which was one of the earliest of his works, that are extant (*Vid. Sparkii præf. ad Lactant.*), 40 years before, viz. about *anno Chrijti* 280; which brings us up to 200 years after the overthrow of Herculaneum, as above.

On Sunday the 5th of March I was sent for to a gentleman, of about 30 years of age, who had been for some days ill of a fever. I found him with a degree of heat considerably above what was natural, and with a pulse rather low, but quick, and beating, as measured by a stop-watch, about a hundred strokes in a minute. In this situation he continued, without any remarkable alteration, for the two following days; and, from the appearance of this disease, I imagined, that it would not be speedily terminated. On Wednesday, the third day of my seeing him, I found him however much better; his heat being considerably abated, and his pulse being more than twenty strokes in a minute slower than it had been the day before. On this alteration, so much in his favour, it might have been thought he was growing well, had it not been, that there was no appearance either by sweat or urine, or on the skin, by which it could be imagined the disease was perfectly judged. On this account no alteration was made in his treatment that day: but finding, the next morning, that he had slept well the preceding night, and that his pulse continued quiet, being no more than 74 strokes in a minute, he was allowed to get up in the evening, to have his bed made; and I should have thought him well, had not every appearance of a critical separation been still wanting. On this account, I thought him to be very liable to a return of his fever; and therefore, when early the next morning I was informed, that he had been without any sleep, and quite delirious, the whole night, I was not greatly alarmed, as thinking he had a feverish paroxysm, to which the bark would probably put an end. When I saw him  
that

that morning, I found him very delirious ; but, to my great surprise, quite free from all kind of fever whatever ; his pulse being then as calm as it had been the preceding day. In this condition he remained all that day, and the following night ; nothing, that was attempted to relieve him, having done him the least service : on the contrary, his delirium increased so much, as to make it very difficult for the attendants to keep him in bed. The next morning he was much as he had been the day before ; imagination continuing greatly disturbed, and he at times laughing, and playing antic tricks, and using gestures the most opposite to his common demeanour when well ; and which, tho' the pulse had not been so perfectly quiet, had more the appearance of a *mania*, than of the delirium of a fever. In this unhappy situation, there was but one thing, which seemed likely to bring the affair to a speedy determination : this it was proper to attempt, tho' the indications for it were very obscure, and the event perfectly uncertain. On recollecting the time of this delirium's coming on, which was about 36 hours after the pulse had grown quiet ; and perceiving, that one glass of the water, which had been made in the night, was thick, and seemed disposed to drop a sediment ; there was some reason to suspect, and indeed to hope, that tho' the pulse had been perfectly calm during the whole time of the delirium, there was something of the fever still at the bottom of this complaint. From these indications, obscure as they were, it was judged proper to make a trial of the bark ; which was accordingly ordered to be taken immediately, and to be repeated every two hours.



This method succeeded beyond what could have been imagined; infomuch that it was observable, even by the attendants on this gentleman, that his mind came evidently more and more to itself after every dose: and in the evening, after he had taken six drachms, his urine grew thick, and dropt a lateritious sediment; and, excepting the weakness naturally consequent on such violent emotions as he had undergone, both of mind and body, he was as well as ever he had been in his life. He hath repeated the bark at proper intervals, as is usual after intermittent fevers, and continues to this day perfectly well.

The use of the bark, in the most irregular intermittent disorders, is very happily so well known in this island, that it might perhaps have been thought needless to have recited any case merely in confirmation of this practice: and I am too well aware of the insufficiency of every thing, but a number of facts on which to found any philosophical truth, to presume to rest any thing on one single instance only. But the case above related is of so very extraordinary a kind, as to make it worthy of being mentioned, both on its own account, and for that analogy, which being found by experience to subsist between diseases, affords the surest method of reasoning on practical subjects. The two remarkable circumstances of this case are, the delirium's coming on, and continuing, without any exacerbation of the pulse; and the bark's proving so speedy and effectual a remedy, tho' given at a time, when there was no appearance of any remission of the symptom, which it was intended to remove. It hath been thought, that a quick pulse is  
so

so essential to the definition of a fever, as to be a pathognomonic symptom of it. But experience is against this notion: perhaps the present case is a proof of the contrary; however this be, there have not been wanting instances, in which, towards the end of a fever, the pulse has grown quiet, without the abatement of any other symptom, and the patient hath generally lain comatose, and with the appearance of one, who hath taken a large quantity of opium. Galen, in the third book of the Presages of the Pulse, mentions this symptom, and pronounces it to be almost a fatal sign: and the same thing hath happened in more instances than one, which have come to my knowledge. May not then the above-recited case lead to this useful inquiry, Whether in fevers of every kind, when the pulse is quiet, the bark is not proper to be given, and likely to prove a remedy? In this case it proved absolutely such: and that it is at least a safe medicine in all such cases, in which any practitioner of experience or judgment would ever think of giving it, is now certainly known. For my own part, I can safely declare, that in near ten years experience of it in Guy's-Hospital, during which time I find I have given it, on different occasions, to above five hundred patients in that house only, I never, from the most accurate observation I could make, saw it do any harm, or bring on any bad symptom, even in cases where it did not succeed according to the intention for which it was ordered; and (which I have thought worth remarking) in chronical cases, even in those, where the bark hath been by many thought the most prejudicial, when, on the coming on of an intermittent fever, the bark  
hath

hath been necessary to cure this secondary disease, the original distemper hath gone on, according to the best judgment I could form of it, exactly in the same manner, as it would have done had the bark never been given.

LXXXII. *An Account of an Earthquake felt at Lingfield in Surrey, and Edenbridge in Kent, on the 24th of January 1758. By James Burrow, Esq; R. S. V. P.*

Read April 6, 1758. **I**N the London Chronicle, N<sup>o</sup>. 181, published on the 25th of February 1758, in page 155, is the following article: " We hear, that about two o'clock in the morning of the 24th of last month" (which was the month of January), " an Earthquake was felt in the parishes of Worthe, and East-Grinstead, in Suffex; Lingfield, in Surrey; and Edenbridge, in Kent; and other adjacent places: which alarmed several of the inhabitants very much; but no damage ensued."

Mr. Burrow, having some connection with these two last parishes of Lingfield and Edenbridge, immediately wrote to the Rev. Mr. Goodricke of Lingfield, to inquire into the truth of this report: and Mr. Goodricke's answer confirmed the fact of its being felt there, and at other adjacent places; and added, " that it shook the beds and windows, and  
" made

“ made the plates rattle ; and went off with a noise,  
 “ like a small gust of wind.”

However, Mr. Burrow did not then judge it to be either regular or proper to trouble the Society with this account ; because Mr. Goodricke only received it from hearsay and report, he himself happening to be absent from Lingfield at that time.

But Mr. Burrow having passed some days, during the late recess of the Society, at a place called Starborough-castle, which lies nearly *between* the two churches of Lingfield and Edenbridge (scarce four miles distant from each other), he has had an opportunity of being more particularly and circumstantially informed of the fact, as far as relates to those two parishes : and he is now assured, that it was certainly and undoubtedly felt and observed by *some* persons in each of those two parishes ; tho’ (as it happened in the dead of the night, when most people were fast asleep) it was not *generally* perceived : nor was it much spoken of, even by those, who were sure they felt it.

The persons, from whose own mouths he can authenticate the fact, are James Martin, Adam Killick, Mrs. Jewell, and Mr. Chapman : and he has no less doubt as to Mr. Orgles and Mrs Pigott (who was waked and much frightened by it), tho’ he did not indeed personally converse with either of the two last.

These two, and Mrs. Jewell, all inhabit quite close to Lingfield church-yard, on different sides of it : and Chapman lives within a quarter of a mile of it, to the south-west.

James Martin lives within a bow-shot of Starborough-castle, at the eastern edge of the parish of  
 Lingfield,

Lingfield, where it joins to that of Edenbridge ; and Adam Killick's habitation is three miles north-east of Starborough, at the north-western point of the parish of Edenbridge.

All these four, with whom Mr. Burrow personally conversed, agreed as to the *time* of the concussion ; *viz.* between one and two in the morning : and they all agreed as to the *shaking* of their beds and windows ; and all of them described the *continuance* of the shock as not much more than instantaneous : but they did *not* all hear the *noise*, which *some* of them observed it to conclude with ; particularly Adam Killick heard *no noise* at all ; and yet, he says, he was broad awake when it first began : and it shook his house and bed, and made his windows rattle so much, that he was apprehensive of their being broken ; and even caused one pane of glass (which was indeed loose before) actually to drop out. But James Martin, who was likewise fully awake (as was his wife too), *did bear* the noise distinctly. He says, he felt his house and bed shake, heard his windows rattle, and some earthen ware clatter upon a chest of drawers ; and also heard a noise, like the distant discharge of a cannon : whereupon he immediately said to his wife, " Lord ! what is *that* ? " but she happening, at that very instant, either to cough or sneeze (she cannot recollect which of the two), did not, tho' quite awake, perceive any thing at all of the matter. However, she confirmed her husband's asking her this question under an apparent surprize.

Mr. Burrow had a very particular conversation with these two separately : and he had also a very minute detail from Adam Killick (who works for him

him as a sort of gardener at Starborough); who further added, "that the shock waked and frighted his  
" wife, tho' she was fast asleep before."

6th April, 1758.

James Burrow.

**LXXXIII.** *An Account of the Case of the First Joint of the Thumb torn off, with the Flexor Tendon in its whole Extent torn out. By Robert Home, late Surgeon to the Thirtieth Regiment of Foot, and Surgeon at Kingston upon Hull. In a Letter to John Pringle, M. D. F. R. S.*

S I R,

Read April 6, 1758. **I** Take the liberty of inclosing to you a case in surgery, which I imagine is not very common. Marchetis indeed has an observation of the same kind; and there are several others collected together by Monf. Morand, in the second volume of the Memoires of the Royal Academy of Surgery at Paris: but as I have not heard of that volume's being translated into English, and believe there is no observation of a similar nature in the Philosophical Transactions, I beg the favour of you to communicate it to the Royal Society, of which you are a Fellow; and at the same time to make them an offer of the joint of the thumb, with its adherent tendon, which you will receive ~~at the~~ same

same time with this; hoping they will do me the honour of accepting it, as a testimony (tho' trifling) of my great esteem and respect for the most learned Society in Europe Your Friend Dr. Knox saw the patient dressed oftener than once; and Mr. Thornhill, late Surgeon and Manmidwife in Bristol, saw it when near healed.

I beg you will believe me to be, with great truth,

S I R,

Your most obedient,

and most humble Servant,

Hull, March 27th,  
1758.

Robert Home.

Anuary 2d, 1758, William Taylor, 17 years of age, an apprentice to a white-smith in this place, in endeavouring to make his escape from one, who was going to correct him, opened the door of a cellar, and threw himself into it; but in his hurry so intangled his right thumb with the latch, that the whole weight of his body was suspended by it, until it gave way, and was torn off at the first articulation; the flexor tendon being at the same time pulled out in its whole length, having broke when it became muscular. I was immediately sent for, found little or no hæmorrhage, and the bone of the second phalanx safe, and covered with its cartilage, but protruding considerably, occasioned by part of the skin belonging to it being irregularly torn off with the first joint.

I was doubtful, whether or not I should be obliged, at last, to make a circular incision, and saw the

the bone even with the skin; but thought it proper to give him a chance for the use of the whole phalanx.

He complained only for the first day of a pretty sharp pain in the course of the tendon; to which compresses, wrung out of warm brandy, were applied: but his arm was never swelled; there was no *ecchymosis*; nor had he so much fever, as to require bleeding even once. The cure proceeded happily, no symptoms arising from the extracted tendon. At the third dressing the bone was covered; and no other application but dry lint was necessary during the whole time. No exfoliation happened; yet it was twelve weeks before it was intirely cicatrised, owing to the loss of skin: and he seems to enjoy the use of the stump as completely, as if that tendon was not lost.

LXXXIV. *An Account of the late Discoveries of Antiquities at Herculaneum, and of an Earthquake there; in a Letter from Camillo Paderni, Keeper of the Museum at Herculaneum, and F.R.S. to Tho. Hollis, Esq; F.R.S. dated Portici, Feb. 1. 1758.*

Read April 6, 1758. **W**E have been working continually at Herculaneum, Pompeii, and Stabiae, since my last of Dec. 16, 1756. The most remarkable discoveries made there are these, which follow.



February 1757, was found a small and most beautiful figure of a naked Venus in bronze, the height of which is fix Neapolitan inches. She has silver eyes, bracelets of gold on her arms, and chains of the same metal above her feet; and appears in the attitude of loosening one of her sandals. The base is of bronze inlaid with foliage of silver, on one side of which is placed a dolphin.

In July we met with an inscription, about twelve Neapolitan palms in length, which I have here copied.

IMP. CAESAR. VESPASIANVS. AVG. PONTIF. MAX  
 TRIB. POT. VII. IMP. XVII. P. P. COS. VII. DESIGN. VIII  
 TEMPLVM. MATRIS. DEVM. TERRAE. MOTV. CONLAPSV. RESTITVIT

After having found a great number of volumes of papyrus in Herculaneum; many pugillaries, styles, and stands with ink in them, as formerly mentioned; at length, in the month of August, upon opening a small box, we also found, to our exceeding great joy, the instrument, with which they used to write their manuscripts. It is made of wood, of an oblong form, but petrified, and broke into two pieces. There is no slit in it, that being unnecessary, as the ancients did not join their letters in the manner we do, but wrote them separate.

In September were discovered eight marble busts, in the form of terms. One of these represents Vitellius, another Archimedes; and both are of the finest workmanship. The following characters, in a black tint, are still legible on the latter, namely, APXIME△ which is all the inscription that now remains.

In October was dug up a curious bust of a young person, who has a helmet on his head, adorned with a civic crown, and cheek-pieces fastened under his chin. Also another very fine bust of a philosopher, with a beard, and short thick hair, having a slight drapery on his left shoulder. Likewise two female busts; one unknown, in a veil; the other Minerva, with a helmet; both of middling workmanship.

In November we met with two busts of philosophers, of excellent workmanship, and, as may be easily perceived, of the same artist; but unfortunately, like many others, without names.

In January was found a small, but most beautiful eagle, in bronze. It hath silver eyes, perches on a *praefericulum*, and holds a fawn between its talons.

In the same month we discovered, at Stabia, a term fix palms high, on which is a head of Plato, in the finest preservation, and performed in a very masterly manner. Also divers vases, instruments for sacrificing, scales, balances, weights, and other implements for domestic uses, all in bronze.

At length I have finished, with much labour, the examination and arrangement of the scales, balances, and weights, which are very numerous in this museum; and, what is remarkable, many of the former, with all the weights, exactly answer those now in use at Naples. At present I am considering the liquid measures; and also engaged in disposing the paintings in the new apartment allotted for them. These affairs, with my usual province of inspecting the workmen, who are busied in digging; my being obliged to keep an exact register of every thing, that is discovered;

covered ; besides other daily and accidental occurrences ; employ my time so intirely, that I have not a moment's repose, but in my bed.

The square belonging to the palace, in which the museum is deposited, will be finished, and completely ornamented, by Easter. In the center of it I have placed the bronze horie, which was broken in many pieces, and restored by me, as mentioned in my last. In the walls of the colonades are affixed all the inscriptions hitherto discovered : and I shall yet adorn them with altars, curule chairs, and other antiquities proper for such places. The principal entrance into the museum hath been made to correspond with the grand stair-case. On the right side of it stands the consular statue of Marcus Nonius Balbus, the father ; and on the left, that of Marcus Nonius Balbus, the son ; with two inscriptions relating to, and found near them. Upon the stair-case are placed eight antique statues in bronze, on beautiful pedestals of polished marble. In an opening in the center of the right hand colonade is fixed the statue of the wife of the elder Balbus, with the antique inscription belonging to it. At the entrance of the square, a magnificent pair of iron gates, with palisades, are just put up, ornamented with many bronzes, which are gilt ; and on the sides of these gates are two other consular statues of persons unknown.

The whole day and night of the 24th of last month it seemed as if Mount Vesuvius would again have swallowed up this country. On that day it suffered two internal fractures, which intirely changed its appearance within the crater, destroying the little  
mountain,

mountain, that had been forming within it for some years, and was risen above the sides; and throwing up, by violent explosions, immense quantities of stones, lava, ashes, and fire. At night the flames burst out with greater vehemence. the explosions were more frequent and horrible, and our houses shook continually. Many fled to Naples, and the boldest persons trembled. For my own part, I resolved to abide the event here at Portici on account of my family, consisting of eight children, and a very weak and aged mother, whose life must have been lost by a removal in such circumstances, and so rigorous a season. But it pleased God to preserve us; for the mountain having vented itself that night and the succeeding day, is since become calm, and throws out only a few ashes.

LXXXV. *A further Attempt to facilitate the Resolution of Isoperimetrical Problems.*  
By Mr. Thomas Simpson, F. R. S.

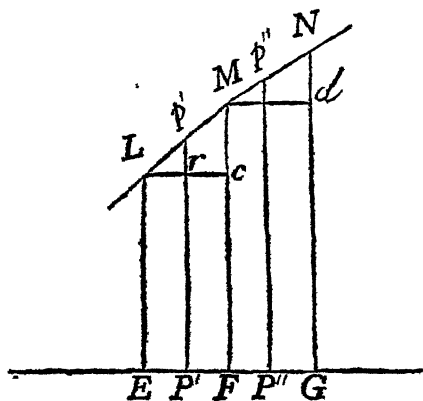
Read April 13.  
1758.

ABOUT three years ago I had the honour to lay before the Royal Society the investigation of a general rule for the resolution of isoperimetrical problems of that kind, wherein one, only, of the two indeterminate quantities enters along with the fluxions, into the equations expressing the conditions of the problem. Under which kind are included the determination of the greatest figures under given bounds, lines of the swiftest descent, solids

of the least resistance, with innumerable other cases. But altho' cases of this sort do, indeed, most frequently occur, and have therefore been chiefly attended to by mathematicians, others may nevertheless be proposed, such as actually arise in inquiries into nature, wherein *both* the flowing quantities, together with their fluxions, are jointly concerned. The investigation of a *rule* for the resolution of these, is what I shall in this paper attempt, by means of the following

### GENERAL PROPOSITION.

*Let  $Q, R, S, T$ , &c. represent any variable quantities, expressed in terms of  $x$  and  $y$  (with given coefficients), and let  $q, r, s, t$ , &c. denote as many other quantities, expressed in terms of  $\dot{x}$  and  $\dot{y}$ ; It is proposed to find an equation for the relation of  $x$  and  $y$ , so that the fluent of  $Qq + Rr + Ss + Tt$ , &c. corresponding to a given value of  $x$  (or  $y$ ), may be a maximum or minimum.*



Let

Let  $AE$ ,  $AF$ , and  $AG$ , denote any three values of the quantity  $x$ , having indefinitely small *equi-differences*  $EF$ ,  $FG$ ; and let  $EL$ ,  $FM$ , and  $GN$ , (perpendicular to  $AG$ ) be the respective values of  $y$ , corresponding thereto; and, supposing  $EF (=FG=\dot{x})$  to be denoted by  $e$ , let  $cM$  and  $dN$  (the successive values of  $y$ ) be represented by  $u$  and  $w$ . Moreover, supposing  $P'p'$  and  $P''p''$  to be ordinates at the middle points  $P'P''$ , between  $E, F$  and  $F, G$ , let the former ( $P'p'$ ) be denoted  $\alpha$ , and the latter ( $P''p''$ ) by  $\beta$ ; putting  $AP'=a$  and  $AP''=b$ . Then, if  $a$  and  $\alpha$  (the mean values of  $x$  and  $y$ , between the ordinates  $EL$  and  $FM$ ) be supposed to be substituted for  $x$  and  $y$ , in the given quantity  $\mathcal{Q}q + Rr + Ss + Tt, \&c.$  and if, instead of  $\dot{x}$  and  $\dot{y}$ , their equals  $e$  and  $u$  be also substituted, and the said (given) quantity, after such substitution, be denoted by  $\mathcal{Q}'q' + R'r' + S's' + T't', \&c.$  it is then evident, that this quantity  $\mathcal{Q}'q' + R'r' + S's' + T't', \&c.$  will express so much of the whole required fluent, as is comprehended between the ordinates  $EL$  and  $FM$ , or as answers to an increase of  $EF$  in the value of  $x$ . And thus, if  $b$  and  $\beta$  be conceived to be wrote for  $x$  and  $y$ ,  $e$  for  $\dot{x}$ , and  $w$  for  $\dot{y}$ , and the quantity resulting be denoted by  $\mathcal{Q}''q'' + R''r'' + S''s'' + T''t'', \&c.$  this quantity will, in like manner, express the part of the required fluent corresponding to the interval  $FG$ . Whence that part answering to the interval  $EG$  will consequently be equal to  $\mathcal{Q}'q' + R'r' \&c. + \mathcal{Q}''q'' + R''r'' \&c.$  But it is

manifest, that the whole required fluent cannot be a *maximum* or *minimum*, unless this part, supposing the bounding ordinates  $EL$ ,  $GN$  to remain the same, is also a *maximum* or *minimum*. Hence, in order to determine the fluxion of this expression ( $\mathcal{Q}'q' + R'r' \&c.$   $\mathcal{Q}''q'' + R''r'' \&c.$ ) which must, of consequence, be equal to nothing, let the fluxions of  $\mathcal{Q}$  and  $q'$  (taking  $\alpha$  and  $u$  as variable) be denoted by  $\mathcal{Q}\alpha$  and  $\bar{q}u$ ; also let  $\bar{R}\alpha$  and  $\bar{r}u$  denote the respective fluxions of  $R'$  and  $r'$ ; and let, in like manner, the fluxions of  $\mathcal{Q}''$ ,  $q''$ ,  $R''$ ,  $r''$ ,  $\&c.$  be represented by  $\mathcal{Q}\beta$ ,  $\bar{q}w$ ,  $\bar{R}\beta$ ,  $\bar{r}w$ ,  $\&c.$  respectively. Then, by the common rule for finding the fluxion of a rectangle, the fluxion of our whole expression ( $\mathcal{Q}'q' + R'r' \&c. + \mathcal{Q}''q'' + R''r'' \&c.$ ) will be given equal to  $\mathcal{Q}'\bar{q}u + q'\mathcal{Q}\alpha + R'\bar{r}u + r'\bar{R}\alpha \&c. + \mathcal{Q}''\bar{q}w + q''\mathcal{Q}\beta + R''\bar{r}w + r''\bar{R}\beta \&c. = 0$ .

But  $u + w$  being  $= GN - EL$ , and  $\beta - \alpha = \frac{GN - EL}{2}$  (a constant quantity), we therefore have

$\bar{r}' = -u$ , and  $\beta = \alpha$ : also  $u$  being  $(= 2rp') = 2\alpha - 2EL$ , thence will  $u = 2\alpha$ : which values being substituted above, our equation, after the whole is divided by  $\alpha$ , will become

$$2\mathcal{Q}'\bar{q} + q'\mathcal{Q} + 2R'\bar{r} + r'\bar{R}, \&c. - 2\mathcal{Q}''\bar{q} + q''\mathcal{Q} - 2R''\bar{r} + r''\bar{R}, \&c. = 0;$$

$$\text{or, } \mathcal{Q}''\bar{q} - \mathcal{Q}'\bar{q} + R''\bar{r} - R'\bar{r} \&c. = \frac{q'\mathcal{Q} + q''\mathcal{Q}}{\alpha} + \frac{r'\bar{R} + r''\bar{R}}{\alpha}, \&c.$$

But

But  $\mathcal{Q}''\bar{q} - \mathcal{Q}'\bar{q}$ , the excess of  $\mathcal{Q}''\bar{q}$  above  $\mathcal{Q}'\bar{q}$ , is the increment or fluxion (answering to the increment, or fluxion,  $\dot{x}$ ) arising by substituting  $b$  for  $a$ ,  $\beta$  for  $\alpha$ , and  $w$  for  $u$ . Moreover, with regard to the quantities on the other side of the equation, it is plain, seeing the difference of  $q'\mathcal{Q}$  and  $q''\mathcal{Q}$  is indefinitely little in comparison of their sum, that  $q'\mathcal{Q}$  may be substituted in the room of  $\frac{q'\mathcal{Q} + q''\mathcal{Q}}{2}$ ,  $\&c.$  which being done, our equation will stand thus:

$$\text{Flux. } \mathcal{Q}\bar{q} + R'\bar{r} \&c. = q'\mathcal{Q} + r'\bar{R} \&c.$$

But  $q'\mathcal{Q} + r'\bar{R} \&c.$  represents (by the preceding notation) the fluxion of  $q'\mathcal{Q} + r'\bar{R} \&c.$  (or of  $\mathcal{Q}q + Rr \&c.$ ) arising by substituting  $\alpha$  for  $y$ , making  $\alpha$  alone variable, and casting off  $\dot{\alpha}$ . If, therefore, that fluxion be denoted by  $\dot{v}$ , we shall have  $\text{flux. } \mathcal{Q}\bar{q} + R'\bar{r} \&c. = \dot{v}$ , and consequently  $\mathcal{Q}\bar{q} + R'\bar{r} \&c. = v$ . But  $\mathcal{Q}\bar{q} + R'\bar{r} \&c.$  (by the same notation) appears to be the fluxion of  $\mathcal{Q}q' + R'r' \&c.$  (or of  $\mathcal{Q}q + Rr \&c.$ ) arising by substituting  $u$  for  $y$ , making  $u$  alone variable, and casting off  $\dot{u}$ . Whence the following

### GENERAL RULE.

*Take the fluxion of the given expression (whose fluent is required to be a maximum or minimum) making  $y$  alone variable; and, having divided by  $\dot{y}$ , let the quotient be denoted by  $v$ : Then take, again, the fluxion of the same expression, making  $y$  alone variable, which divide by  $\dot{y}$ ; and then this last quotient will be  $= \dot{v}$ .*



When  $y$  is not found in the quantity given,  $v$  will then be  $= 0$ ; and, consequently, the expression for  $i$ , equal to nothing also. But if  $y$  be absent, then will  $i = 0$ , and consequently the value of  $v = a$  constant quantity. It is also easy to comprehend, that, instead of  $y$  and  $y$ ,  $\dot{x}$  and  $\dot{x}$  may be made successively variable. Moreover, should the case to be resolved be confined to other restrictions, besides that of the *maximum* or *minimum*, such as, having a certain number of other fluents, at the same time, equal to given quantities, still the same method of solution may be applied, and that with equal advantage, if from the particular expressions exhibiting all the several conditions, one general expression composed of them all, with unknown (but determinate) coefficients, be made use of.

In order to render this matter quite clear, let  $A$ ,  $B$ ,  $C$ ,  $D$ , &c. be supposed to represent any quantities expressed in terms of  $x$ ,  $y$ , and their fluxions, and let it be required to determine the relation of  $x$  and  $y$ , so that the fluent of  $A\dot{x}$  shall be a *maximum*, or *minimum*, when the cotemporary fluents of  $B\dot{x}$ ,  $C\dot{x}$ ,  $D\dot{x}$ , &c. are, all of them, equal to given quantities.

. It is evident, in the first place, that the fluent of  $A\dot{x} + bB\dot{x} + cC\dot{x} + dD\dot{x}$ , &c. ( $b$ ,  $c$ ,  $d$ , &c. being any constant quantities whatever) must be a *maximum*, or *minimum*, in the proposed circumstance: and, if the relation of  $x$  and  $y$  be determined (*by the rule*), so as to answer this single condition (under all possible

possible values of  $b, c, d, \&c.$ ) it will also appear evident, that such relation will likewise answer and include all the other conditions propounded. For, there being in the general expression, thus derived, as many unknown quantities  $b, c, d, \&c.$  (to be determined) as there are equations, by making the fluents of  $B \dot{x}, C \dot{x}, D \dot{x}, \&c.$  equal to the values given; those quantities may be so assigned, or conceived to be such, as to answer all the conditions of the said equations. And then, to see clearly that the fluent of the first expression,  $A \dot{x}$ , cannot be greater than arises from hence (other things remaining the same) let there be supposed some other different relation of  $x$  and  $y$ , whereby the conditions of all the other fluents of  $B \dot{x}, C \dot{x}, D \dot{x}, \&c.$  can be fulfilled; and let, *if possible*, this new relation give a greater fluent of  $A \dot{x}$  than the relation above assigned. Then, because the fluents  $b B \dot{x}, c C \dot{x}, d D \dot{x}, \&c.$  are given, and the same in both cases, it follows, according to this supposition, that this new relation must give a greater fluent of  $A \dot{x} + b B \dot{x} + c C \dot{x} + d D \dot{x}, \&c.$  (under all possible values of  $b, c, d, \&c.$ ) than the former relation gives: *which is impossible*; because (whatever values are assigned to  $b, c, d, \&c.$ ) that fluent will, it is demonstrated, be the greatest possible, when the relation of  $x$  and  $y$  is that above determined, by the General Rule.

To exemplify, now, by a particular case, the method of operation above pointed out, let there be  
 4. proposed

proposed the fluxionary quantity  $\frac{x^n y^m \dot{y}^p}{x^{p-1}}$ ; wherein the relation of  $x$  and  $y$  is so required, that the fluent, corresponding to given values of  $x$  and  $y$ , shall be a *maximum*, or *minimum*. Here, by taking the fluxion, making  $y$  alone variable (*according to the rule*) and dividing by  $\dot{y}$ , we shall have  $\frac{p x^n y^m \dot{y}^{p-1}}{x^{p-1}} = u$ . And, by taking the fluxion a second time, making  $y$  alone variable, and dividing by  $\dot{y}$ , will be had  $\frac{m x^n y^{m-1} \dot{y}^p}{x^{p-1}} = \dot{u}$ . Now from these equations to exterminate  $u$ , let the latter be divided by the former; so shall  $\frac{m \dot{y}}{p y} = \frac{\dot{u}}{u}$ ; and therefore  $a y^{\frac{m}{p}} = u$  ( $a$  being a

constant quantity). From whence  $y^{\frac{m}{p}} \dot{y} = \frac{\dot{a}}{p} \frac{1}{a^{\frac{1}{p}-1}} \times x^{\frac{p-n}{p-1}}$ ; and consequently  $\frac{p}{m+p} \times y^{\frac{m+p}{p}} = \frac{\dot{a}}{p} \frac{1}{a^{\frac{1}{p}-1}} \times \frac{p-1}{p-n-1} \times x^{\frac{p-n-1}{p-1}}$ .

Let there be now proposed the two fluxions  $x^n y^m \dot{x}$  and  $x^p y^q \dot{y}$ , the fluent of the former being required to be a *maximum*, or *minimum*, and that of the latter, at the same time, equal to a given quantity. Then the latter, with the general coefficient  $b$  prefixed, being joined to the former, we shall here have  $x^n y^m \dot{x} + b x^p y^q \dot{y}$ . From whence, by proceeding as before,  $b x^p y^q = u$ , and  $m x^{n-1} y^m \dot{x} + q b x^p y^{q-1} \dot{y} = \dot{u}$ .

From

From the former of which equations, by taking the fluxions on both sides, will be had  $pby^{p-1}y^q\dot{x} + qbx^p y^{q-1}\dot{y} (= \dot{v}) = mx^m y^{n-1}\dot{x} + qbx^p y^{q-1}\dot{y}$ . Whence  $pby^{p-1}y^q = mx^m y^{n-1}$ ; and therefore  $pby^{q-p+1} = mx^{n-p+1}$ . And in the same manner proper equations, to express the relation of  $x$  and  $y$ , may be derived, in any other case, and under any number of limitations.

LXXXVI. *Observations on the Alga Marina latifolia; The Sea Alga with broad Leaves.*  
By John Andrew Peyffonel, M.D. F.R.S.  
*Translated from the French.*

Read April 13. 1758. **H**AVING cast anchor at Verdun, the road at the entrance of the river of Bourdeaux, I was fishing with a kind of drag-net upon a bank of sand, which was very fine and muddy. We collected a number of sea-plants, and among them the great broad-leaved Alga, which I did not know: and as the root or pedicle of this plant appeared to be very particular, I observed it with attention. The following is its description, and the detail of my observations.

From a pedicle, which is sometimes flat, and sometimes round (for they vary in these plants, and might be about three lines in diameter, and an inch high, of a blackish colour, and coriaceous substance, approaching to the nature of the bodies of lithophyta),  
a single

a single flat leaf arises, about an inch or an inch and half broad, thick in its middle to about three lines, ending at the sides in a kind of edge, like a two-edged sabre, almost like the common Alga, formed of longitudinal fibres interlaced with other very delicate ones, and the whole filled with a thick juice, like the *parenchyma* of succulent plants, such as the Sedum, Aloes, and the like, of a clear yellowish green, and transparent. This first leaf is always single, and serves instead of a trunk or stem to the whole plant.

When it rises to about a foot high, more or less, it throws out at the sides other leaves formed of a continuation of the longitudinal fibres; and these second leaves are of the same thickness and substance with the first: they are two or three feet long, and the whole plant is five or six, or more (for one can hardly tell the length); and is not capable of supporting itself, but is sustained by the strength of the waters, in which it floats.

The substance of the plant is not so solid as that of the common Alga, which is capable of drying as it fades, and of being kept: whereas the leaves of this great Alga shrink and wither in the air, become of a blackish colour, and very friable, or indeed soon fall into putrefaction. I never observed, that they bore any fruit: perhaps this was not the season.

But what we find particular in this plant is its root or foot: First, this pedicle extends in ribs, like what we call the thighs of certain trees: these thighs are in right lines: perhaps they run in the same direction or situation, that is, placed north and south, or east and west; but this I could not observe. They are  
about

about three or four lines high towards the pedicle, and, ending, are lost. They flourish and spread at the bottom, forming an elliptical bladder, like an egg, flattened above and below, and rounded at the sides, being intirely empty: it is rough without, and very smooth within. This egg, or oval bladder, is exactly round at the ends of the great diameter, but varies a little in the lesser diameter, and forms itself like the body of a fiddle. The under part is a little flattened; and there is a hole, which is very considerable, in the center of the two diameters. This hole is about an inch wide, and is quite round: it gives passage to the root, or pivot, which I shall by and by mention: the edges appear to turn a little inward: and it is by this hole that the egg fills with sea-water. The whole substance of this bladder or egg is of a coriaceous matter, firm and transparent, and of a clear green; nor can there be any fibres, either longitudinal or transverse, observed upon it.

The vault at the top, surmounted by the thighs, is as it were granulated; but at the rounding of the egg it produces a kind of *mammæ*, or little elevations, very round and cylindrical, intirely full; of the same nature and substance with the egg.

In examining the under part of the egg, we found a second rank of these *mamellæ*, somewhat longer than the first, and at equal distances from one another, in a circular line; then a third yet longer; then a fourth, which at the extremities were bifurcated; and at last a fifth rank, which divided into three, and sometimes into five, branches: these last, placed round the hole, were wreathed inwards, and several were joined together, and only formed a small

body; and in wreathing themselves thus they close and embrace the pivot mentioned below. None of these *mamellæ* have any apparent opening: their substance is compact, of the same nature with the bladder or egg, that produces them.

Below the trunk and thighs the plant protrudes a pivot, of a like substance with that of the bladder. This pivot, which is large at its origin, proceeding thus from the trunk and thighs, forms something like the knot of the sea-tree: it descends perpendicularly to the trunk, diminishing as it lengthens, and as it grows round; and then divides into a number of *mamellæ*, branched and wreathed inwards so firmly, as not to be retracted; of a coriaceous nature, blackish, forming a bunch like what we call the Rose of Jericho. I cannot recollect the name of this plant or flower.

This bunch, or wreathed rose, incloses a heap of gravel, as if petrified or hardened, and ends upon a level with the hole of the egg, exactly as high as the last rank of *mamellæ*, which wreath upon, embrace, and sustain it, leaving always an empty space to let the sea-water pass in, which should fill the inside of the egg or bladder, and even to let in little fishes and shells.

I was surprised to find in one little living muscles, as they always are attached to some solid body by their beards. Now by what means could they enter into this egg? I conjectured, that they had their beginning there, by the seminal matter of muscles carried in by the sea-water. I also found some small star-fish, whose rays might be about four or five lines long.

If my stay here had been longer, I had continued my observations; and perhaps should have made some discoveries. It belongs to the academicians of Bourdeaux to push these observations further, if they think proper.

From the Entrance of the  
river of Bourdeaux, the  
4th of August, 1756.

Peyfforel.

LXXXVII. *An Account of the distilling Water fresh from Sea-water by Wood-ashes.*  
*By Capt. William Chapman: In a Letter to John Fothergill, M. D.*

Whitby, 10th 2d mo. Feb. 1758.

Read April 13. 1758. **T**HY kind acceptance of my last emboldens me to inform thee, how, on my return from a voyage to the north part of Russia, I procured a sufficient quantity of fresh water from sea-water, without taking with me either instruments or ingredients expressly for the purpose.

Some time in September last, when I had been ten days at sea, by an accident (off the north cape of Finland) we lost the greatest part of our water. We had a hard gale of wind at south-west, which continued three weeks, and drove us into 73° lat. During this time I was very uneasy, as knowing, if our passage should hold out long, we must be reduced to great straits; for we had no rains, but frequent fogs, which yielded water in very small quantities. I now



blamed myself for not having a still along with me (as I had often thought no ship should be without one). But it was now too late ; and there was a necessity to contrive some means for our preservation.

I was not a stranger to Appleby's method : I had also a pamphlet wrote by Dr. Butler, intituled, *An easy Method of procuring of fresh Water at Sea*. And I imagined, that soap might supply the place of capital lees, mentioned by him. I now set myself at work, to contrive a still ; and ordered an old pitch-pot, that held about ten quarts, to be made clean : my carpenter, by my direction, fitted to it a cover of fir deal, about two inches thick, very close ; so that it was easily made tight by luting it with paste. We had a hole thro' the cover, in which was fixed a wooden pipe nearly perpendicular. This I call the still-head : it was bored with an augre of  $1 \frac{1}{2}$  inch diameter, to within three inches of the top or extremity, where it was left solid. We made a hole in this, towards the upper part of its cavity (with a proper angle) to receive a long wooden pipe, which we fixed therein, to descend to the tub in which the worm should be placed. Here again I was at a loss ; for we had no lead pipe, nor any sheet-lead, on board. I thought, if I could contrive a strait pipe to go thro' a large cask of cold water, it might answer the end of a worm. We then cut a pewter dish, and made a pipe two feet long ; and at three or four trials (for we did not let a little discourage us) we made it quite tight. We bored a hole thro' a cask, with a proper descent, in which we fixed the pewter pipe, and made both holes in the cask tight, and filled it with sea-water : the pipe stuck without the  
cask

cask three inches on each side. Having now got my apparatus in readiness, I put seven quarts of sea-water, and an ounce of soap, into my pot, and set it on the fire. The cover was kept from rising by a prop of wood to the bow. We fixed on the head, and into it the long wooden pipe above-mentioned, which was wide enough to receive the end of the pewter one into its cavity. We easily made the joint tight.

I need not tell thee with what anxiety I waited for success: but I was soon relieved; for, as soon as the pot boiled, the water began to run; and in twenty-eight minutes I got a quart of fresh water. I tried it with an hydrometer I had on board, and found it as light as river-water; but it had a rank oily taste, which I imagine was given it by the soap. This taste diminished considerably in two or three days, but not so much as to make it quite palatable. Our sheep and fowls drank this water very greedily without any ill effects. We constantly kept our still at work, and got a gallon of water every two hours; which, if there had been a necessity to drink it, would have been sufficient for our ship's crew.

I now thought of trying to get water more palatable; and often perused the pamphlet above-mentioned, especially the quotation from Sir R. Hawkins's voyage, who "with four billets distilled a hoghead of water wholesome and nourishing." I concluded he had delivered this account under a veil, lest his method should be discovered: for it is plain, that by four billets he could not mean the fuel, as they would scarce *warm* a hoghead of water. When, ruminating on this, it came into my head, that he  
burnt

burnt his four billets to ashes, and with the mixture of those ashes with sea-water he distilled a hoghead of fresh water wholesome and nourishing. Pleased with this discovery, I cut a billet small, and burnt it to ashes; and after cleaning my pot, I put into it a spoonful of those ashes, with the usual quantity of sea-water. The result answered my expectations: the water came off bright and transparent, with an agreeable pungent taste, which at first I thought was occasioned by the ashes, but afterwards was convinced it received it from the resin or turpentine in the pot, or pipes annexed to it. I was now relieved from my fears of being distressed thro' want of water; yet thought it necessary to advise my people not to be too free in the use of this, whilst we had any of our old stock remaining; and told them, I would make the experiment first myself; which I did, by drinking a few glasses every day without any ill effect whatever. This water was equally light with the other, and lathered very well with soap. We had expended our old stock of water before we reached England; but had reserved a good quantity of that which we distilled. After my arrival at Shields, I invited several of my acquaintance on board to taste the water: they drank several glasses, and thought it nothing inferior to spring-water. I made them a bowl of punch of it, which was highly commended.

I have not the convenience of a still here, or should have repeated the experiment for the conviction of some of my friends: for as to myself, I am firmly persuaded, that wood-ashes mixed with sea-water will yield, when distilled, as good fresh water as can be wished for. And I think, if every ship bound a  
long

long voyage was to take a small still with Dr. Hales's improvements, they need never want fresh water. Wood-ashes may easily be made, whilst there is any wood in the ship ; and the extraordinary expence of fuel will be trifling, if they contrive so that the still may stand on the fire along with the ship's boiler.

I shall think myself sufficiently recompensed, if any hints here may tend to the relief of my brother sailors from the dismal extremity of want of water ; an extremity too little regarded by those, who have never experienced it.

*P. S.* During my passage from Russia we very rarely had any *aurora borealis* ; and those few we saw were faint, and of short continuance : at which I was much surpris'd ; for about ten years ago, being in a high north latitude, we had very beautiful ones almost every night in the month of September ; which exceeded any I have seen described in the *Philosophical Transactions*, or *Memoires de l'Academie Royale*.

Wm. Chapman.



IMMERSIONES.				Tempus verum			Differentia
				h	'	"	
Manilius - - - -	{	<i>clar.</i>		10	30	43	— 11
				10	30	54	
Menelaus - - - -	{			—	34	11	— 9
				—	34	20	
Promontorium - -	{			—	44	49	— 9
				—	44	58	
Mare Crifium - -	{			—	45	33	— 11
				—	45	44	
Proclus, <i>clar.</i> - - - -				—	46	54	
Plato - - - - -	{			—	54	48	— 14
				—	55	2	
Langrenus - - - -	{			11	7	3	— 20
				11	7	23	

EMERSIONES.				Tempus verum			Differentia
				h	'	"	
Plato - - - - -	{	<i>clar.</i>		11	40	34	— 14
				11	40	48	
Heraclides - - - -	{			—	41	27	— 12
				—	41	39	
Grimaldus - - - -	{			—	47	57	— 7
				—	48	4	
Keplerus - - - - -	{			—	52	58	— 10
				—	53	8	
Copernicus - - - -	{			12	1	36	— 12
				12	1	48	
Menelaus - - - - -	{			—	17	18	— 10
				—	17	28	
Finis eclipseos, <i>clar.</i> - -				—	52	15	

*Observatio Eclipsis Lunar, facta ab eodem, eodem modo, eodem loco, iisdemque instrumentis Die 24 Januar. Anni 1758.*

*Ab hora 5<sup>a</sup> usque ad finem observationis tantum commovebatur imprægnata plurimum vaporibus atmosphæra, ut tota lunæ illuminatæ portio præter morem undulare videretur. Flabat boreas, indicante thermometro Reaumuriano. 1. grandem infra aquæ congelationem.*

IMMERSIONES.				Tempus verum		Differencia.
				h	"	
Principium. - - -	- - -	- - -	- - -	4	7 42	"
Grimaldus - - -	{	cæ.	- - -	-	9 55	— 38
		clar.	- - -	-	10 33	
Aristarchus - - -	{	- - -	- - -	-	15 37	— 34
		- - -	- - -	-	16 11	
Mare Humorum - - -	{	- - -	- - -	-	20 48	— 24
		- - -	- - -	-	21 12	
Copernicus - - -	{	- - -	- - -	-	26 45	— 13
		- - -	- - -	-	26 58	
Plato - - - - -	{	- - -	- - -	-	35 41	— 41
		- - -	- - -	-	36 22	
Tycho - - - - -	{	- - -	- - -	-	39 31	— 38
		- - -	- - -	-	40 9	
Menclæus - - - -	{	- - -	- - -	-	45 43	— 39
		- - -	- - -	-	46 22	
Plinius - - - - -	{	- - -	- - -	-	50 17	— 27
		- - -	- - -	-	50 44	
Promontorium Somni	{	- - -	- - -	-	58 15	— 27
		- - -	- - -	-	58 42	
Cleomedes - - - -	{	- - -	- - -	5	0 22	— 14
		- - -	- - -	5	0 36	

IMMERSIONES.		Tempus verum			D. de eate
		h	'	"	"
Proclus - - - -	{ <i>cær.</i>	5	2	9	— 6
	{ <i>clar.</i>	5	2	15	
Princip. Maris Crifii -	{ —	—	3	6	— 25
	{ —	—	3	31	
Langrenus - - - -	{ —	—	7	40	— 14
	{ —	—	7	54	
Immerf. tot. Maris Crifii	{ —	—	8	19	— 11
	{ —	—	8	30	
Immerfio totalis Lunæ	{ —	—	12	50	— 40
	{ —	—	13	30	

In fine cœlum serenum, & athmosphæra quieta.

### REFLEXIO.

Notabilis appulsus umbræ terrestris ad faculas maculasque lunares differentia, dum partim vitro colore cæruleo tincto, partim absque eo, observationes instituuntur, inventa a D<sup>o</sup>. de Barros, & tum in observatorio Parisino tum alibi sæpius confirmata, ad me duplicem hanc lunæ eclipsim, ea qua vel licuit circumspeditione, instituendam determinavit, spe fretus; me phænomeni hujus causas, si non veras, veritati saltem proximas, inventurum; unde in tempore de vitris planis bene tersis, diametri mediæ lineæ, partim colore cæruleo claro, partim flavo tinctis mihi provideram, his tamen ultimis uti non licuit ob nimiam umbræ penumbræque confusionem.

Interjecto oculum inter, lentemque ocularem vitri cærulei fragmento, sequentia observavi. 1. Umbra terrestris in immerfione citius maculam aut faculam lunarem attingit, & in emerfione tardius deseruit,



quam dum absque eo observationem institui. 2. Claritas lunæ, alioquin offendens oculum, suavior appareret. 3. Limites umbræ perfecte terminabantur excepta secunda eclipsi, in qua (flante borea) ab hora quinta illuminata lunæ pars undulare videbatur.

Suppositis his phænomenis, uti et athmosphæra lunari, de qua vix dubio locus, sequentia intuli: 1. Quod densior dicta athmosphæra fuerit, major radiorum portio ab hac in immerfam umbræ terrestri lunæ portonem, limitibus saltem proximam, reflectetur, eosque reddet dubios, quod quidem contingit, dum absque adminiculo per nudum telescopium observatio instituitur, secus vero dum oculum inter, lentemque ocularem, vitrum cæruleo colore tinctum interjicitur. Addito secundo, ac tertio phænomeno, nempe per vitrum cæruleum lumen multum apparere suavius, infertur, si color cæruleus sufficit ad mitigandam tantopere eam lunæ illuminatæ portionem, quæ extra omnem umbram conspicitur, quanto magis sufficit, ad tollendam omnem claritatem, quæ ab athmosphæra lunari in hoc corpus reflectitur? & ecce tibi secundam illationem, nempe limites umbræ facilius determinari. 3. Diametrum umbræ majorem videri debere, & vel ideo immerfiones macularum aut facularum lunarium citius, emerfiones vero tardius succedere debere; quæ quidem omnia cum observationibus congruunt.

Dixi in prima illatione, reflecti aliquam luminis portionem a lunæ athmosphæra in ipsam eclipsatam corporis hujus portionem, non secus, ac in globo hoc terraqueo accidit, qui post solis occasum aliquo adhuc tempore illuminatur. Hæc lucis reflexio tanto erit major, quanto athmosphæra fuerit densior, & quia

quia supponere licet, hanc in luna non semper esse æqualem, infertur, differentiam temporis appulsus umbræ non in omni eclipsi lunari posse esse æqualem, quod demum convenire videtur duplici meæ observationi, ut ex adnotatis temporum differentiis liquet. Hæc mea est circa propositum phænomenon opinandi ratio.

LXXXIX. *Observations upon a slight Earthquake, tho' very particular, which may lead to the Knowledge of the Cause of great and violent ones, that ravage whole Countries, and overturn Cities.* By John Andrew Peyssonel, M D. F. R. S. *Translated from the French.*

Read April. 20  
1758. **I** Went to make my observations upon the natural history of the sea; and when I arrived at a place called the Cauldrons of Lance Caraibe, near Lancebertrand, a part of the island of Grande Terre Guadaloupe, in which place the coast runs north-east and south-west, the sea being much agitated that day flowed from the north-west. There the coast is furnished with hollow rocks, and vaults underneath, with chinks and crevices: and the sea, pushed into these deep caverns, by the force and agitation of the waves, compresses the air, which, recovering its spring, forces the water back in the form of the most magnificent fountains;

tains ; which cease, and begin again at every great pressure. This phenomenon is common to many places in this island. The explanation of it is easy ; but the following is what I particularly observed.

As I walked within about forty paces from the brink of the sea, where the waves broke, I perceived, in one place, the plants were much agitated by some cause, that was not yet apparent. I drew near, and discovered a hole about six feet deep, and half a foot diameter ; and stopping to consider it, I perceived the earth tremble under my feet. This increased my attention ; and I heard a dull kind of noise underground, like that which precedes common earthquakes ; which I have observed many a time. It was followed by a quivering of the earth ; and after this a wind issued out of the hole, which agitated the plants round about. I watched to see whether the motion extended to any distance ; but was sensible it did not reach above three or four paces from the hole, and that no motion was perceived farther off.

I further observed, that this phenomenon never happens till after the seventh wave rolls in ; for it is a common thing in this country to find the sea appear calm for some time, and then to produce seven waves, which break upon the coast one after another : the first is not very considerable ; the second is somewhat stronger ; and thus they go on increasing to the seventh, after which the sea grows calm again, and retires. This phenomenon of the seven waves is observed by navigators with great attention, especially at low water, in order to be the better able to go in or come out at the very time  
that

that the sea grows quiet. These seven waves successively fill the caverns, which are all along the coast; and when the seventh comes to open itself, the air at the bottom of the caverns being greatly compressed, acted by its elasticity, and immediately made those fountains and gushings I have mentioned; and the waters continuing in the caverns, up to the very place of the hole, began to produce that dull noise, caused the emotion or earthquake, and finished with the violent wind forced up thro' the hole; after which the water retired into the sea, and having no further impelling cause, on account of the waves, rendered every thing quiet again.

I observed, that this phenomenon happened at no limited time, but according to the approach of the waves, being strongly put in motion after the seventh. I remained near half an hour to observe it; and nearly followed the course of the cavern to its entrance, directed by the disposition of the coast. I made my negroes go down where the water broke; for they doubted the report of the greatness of these caverns; and when the sea was calm one of them ventured in, but returned very quickly, or he must have perished. Therefore I conclude, that these small earthquakes round the hole, about forty paces from the wave, were only caused by the compressed air in some great vault about this place, and that by its force was driven up the hole that appeared: that this air in the caverns, compressed to a certain degree, first caused the dull noise, by the rolling of the waters, which resisted in the cavern; then acting more violently, caused the small earthquake, which ceased when the wind passed out of the hole, and

that

that the sea retired, and gave liberty to the air, which was contained and compressed.

Such are the observations I have made; from which the learned, who are endeavouring to find the cause of earthquakes, since that dreadful one, which destroyed the city of Lisbon, may make such conclusions as they shall think proper.

At Guadeloupe,  
Jan. 6. 1757.

Peyssonel.

**XC.** *A Catalogue of the Fifty Plants from Chelsea Garden, presented to the Royal Society by the worshipful Company of Apothecaries, for the Year 1757, pursuant to the Direction of Sir Hans Sloane, Baronet, Med. Reg. & Soc. Reg. nuper Præses, by John Wilmer, M. D. clariss. Societatis Pharmaceut. Lond. Socius, Hort. Chelsean. Præfectus & Prælector Botanic.*

Read April 20, } 1751 **A** Llium fylvestre latifolium.  
1758. } C. B. P. 74.

Allium urfin. bifolium vernum fylvatic. J. B.  
2. 565.

1752 Anacampseros flavo flore Amman. Ruth. 96.

1753 Anchusa strigosa, foliis linearibus dentatis, pedicellis bractea minoribus, calycibus fructiferis inflatis. Less. Linn. Sp. Plant. 133.

1754 Asplenium sive Ceterach. J. B. 3. 749. Offic.  
121.

1755

- 1755 *Bidens* calyce oblongo squamoso, feminibus  
radii corolla non decidua coronatis, Miller.  
Icon.
- 1756 *Cactus repens* decemangularis Lin. Sp. Pl. 467.
- 1757 *Cerasus pumila* Canadensis, oblongo angusto  
folio, fructu parvo, Du Hamel. Mill. Icons.
- 1758 *Ceratocarpus* Amæn. Acad. 1. p. 412. Hort.  
Upf. 281.
- 1759 *Cotula* flore luteo, radiato. Tourn. 495.  
*Bupthalmum* *Cotulæ* folio C. B. P. 134.
- 1760 *Cracca minor* Rivini. *Vicia* segetum cum fili-  
quis plurimis hirsutis C. B. P. 345.
- 1761 *Cucubalus* calycibus subglobosis glabris reticu-  
lato-venosis, capsulis trilocularibus, corollis  
subnudis, Flor. suec. 360.
- 1762 *Cucubalus* calycibus subglobosis, caule ramoso  
patulo, foliis linearibus acutis, Mill. Dict.  
*Lychnis sylvestris* quæ Been album vulgo, foliis  
angustioribus et acutioribus C. B. P. 205.
- 1763 *Cunonia* floribus sessilibus, spathis maximis.  
Butner *Cunonia*, tab. 1.
- 1764 *Cupressus* foliis imbricatis frondibus ancipiti-  
bus. Linn. Spec. Plant. 1003.  
*Cupressus nana* Mariana fructu cæruleo parvo.  
Pluk. Mantiss. 61.
- 1765 *Cyclamen* *Hederæ* folio C. B. P. 308. Offic. 162.
- 1766 *Diosma* foliis lineari-lanceolatis subtus con-  
vexis, bifariam imbricatis. Linn. Sp. Plant.  
198.
- 1767 *Euonymoides* Canadensis Saraz. Boerh. Ind.  
Alt. 237.
- 1768 *Filipendula* foliis ternatis Hort. Cliff. 191.
- 1769 *Filipendula* vulgaris, an *Molon* Plinii C. B.  
163. Offic. 197.

- 1770 *Heliotropium foliis ovato-lanceolatis, spicis plurimis confertis, caule fruticoso.* Miller's Icons.
- 1771 *Hieracium fruticosum latifolium hirsutum* C. B. P. 129.
- 1772 *Hyoscyamus rubello flore.* C. B. P. 169.  
*Hyoscyamus Syriacus.* Cam. Icon. 21. J. B. 3. 628.
- 1773 *Hypericum floribus monogynis staminibus corolla longioribus, calycibus coloratis caule fruticoso.* Miller's Icons.
- 1774 *Hypericum floribus trigynis, calycibus acutis, staminibus corolla brevioribus, caule fruticoto.* Linn. Hort. Cliff. 380. Miller's Icons.
- 1775 *Iris corollis barbatis, germinibus trigonis, foliis ensiformibus longissimis, caule foliis longiore bifloro.* Miller's Icons.
- 1776 *Isatis fativa, sive latifolia.* C. B. P. 113.  
*Glastrum fativum.* J. B. 2. 909.
- 1777 *Juniperus vulgaris fruticosa* C. B. 488. Off. 252.
- 1778 *Ixia foliis gladiolatis linearibus caule bulbifero.* Miller's Icons.
- 1779 *Ixia foliis gladiolatis glabris, floribus corymbosis terminalibus.* Miller's Icons.
- 1780 *Larix* C. B. 493. Officin. 264.
- 1781 *Laferpitium foliis amplioribus, semine crispo.* Tourn. 324.
- 1782 *Linum calycibus capsulisque obtusis.* *Siberian Flax.* Miller's Icons.
- 1783 *Liriodendrum.* Hort. Cliff. 223.  
*Tulipifera arbor Virginiana.* Hort. Lugd. Bat. 612.
- 1784 *Oenanthe Apii folio* C. B. P. 162.

- 1785 *Passerina foliis linearibus.* Hort. Cliff. 145.  
Sp. 1.  
1786 *Platanus Orientalis verus.* Park. 141.  
1787 *Platanus Occidentalis aut Virginicus.* Park  
1427.  
1788 *Platanus Orientalis Aceris folio.* T. Cor. 21.  
1789 *Prenanthes foliis integris ferratis scabris. radice  
repente, flore purpureo cæruleo.* Mill. Dict.  
1790 *Ruta sylvestris linifolia; Hispanica* Boccon.  
Barrel Icon. 1186 H. Mus. p. 2. 82. tab. 73.  
1791 *Saxifraga muscosa; trifido folio.* Tourn.  
1792 *Scabiosa Virgæ Pastoris folio.* C. B. P. 270.  
*Scabiosa latifolia peregrina.* Tabern. Icon. 160.  
1793 *Thalictrum majus, siliqua angulosa aut striata,*  
C. B. P. 336.  
1794 *Thalictrum majus non striatum.* C. B. P. 336.  
1795 *Thalictrum Canadense majus caulibus viri-  
dantibus.* Boerhaav.  
1796 *Thalictrum Alpinum Aquilegiæ foliis.* Tourn.  
1797 *Thalictrum minus Asphodeli radice magno  
flore.* Tourn. 271.  
1798 *Thuya strobilis squarrosis squamis acuminatis  
reflexis.* Hort. Upsal. 289.  
1799 *Tordylium Narbonense minus.* Tourn. 320.  
1800 *Tridax.* Hort. Cliff. 418. After American.  
*procumbens, foliis laciniatis et hirsutis.*  
Houston.



XCI. *An Historical Memoir concerning a Genus of Plants called Lichen, by Micheli, Haller, and Linnæus; and comprehended by Dillenius under the Terms Ufnea, Coralloides, and Lichenoides: Tending principally to illustrate their several Uses. Communicated by Wm. Watson, M. D. F. R. S.*

— *Natura nihil frustra creaverit. posteros tamen tot inventuros utilitates ex Muscis auguror, quot ex reliquis vegetabilibus.*

Cui bono? Amæn. Acad. III. p. 241.

Read Apr. 27 &  
May 4, 1758.

THE whole class of mosses were taken but very little notice of by the revivers of botany in the sixteenth century: they indeed took some pains to distinguish the particular species that the ancients had mentioned, but disregarded almost all the rest. Modern botanists however suppose, that they were but little successful in general in their application of the ancient names to plants: nor is a failure in such attempts to be wondered at, considering the too great conciseness, and frequent obscurity, of their descriptions. In the class of mosses, as in many others, the accounts transmitted to us are little more than a scene of uncertainty and confusion.

It is to the moderns we are indebted for the discovery of the far greater number of the plants of this class.

class. In this branch of botany our own countrymen Mr. Ray, Buddle, Dale, Doody, Petiver, and Dr. Morison, Sherard, Richardson, and others, have distinguished themselves: and amongst foreigners M. Vaillant, Sig. Micheli, and the very eminent Dr. Haller: but beyond all, the late learned and indefatigable professor at Oxford, Dr. Dillenius, has herein made the most ample discoveries and improvements, of which his elaborate history will ever remain a standing proof.

The word *lichen* occurs in the writings of Dioscorides and Pliny; and tho' it may be doubtful, there is nevertheless good reason to apprehend, that Dioscorides meant to describe under that name the very plant, or at least one of the same genus, to which the commentators agreed to affix his description. Since then the name has been variously applied by different authors: on which account it is necessary to premise, that the *lichen sive hepatica* Off. or liverwort of the shops, does not fall under this generical term, as it is now formed by the three above-named authors. They comprehend under the term *Lichen*, and Dillenius under those of *Usnea*, *Coralloides*, and *Lichenoides*, the hairy tree-moss or *usnea* of the shops; the *muscus pulmonarius*, tree-lungwort, or oak-lungs; the *lichen terrestris cinereus*, or ash-coloured ground liverwort; the coralline-mosses; the cup-mosses; horned mosses; the *orchel*, or Canary-weed; the *muscus islandicus* of Bartholine; and a multitude of others found upon trees, walls, rocks, and stones, in all parts of the world, and in many parts thereof in very great abundance.

Caspar Bauhine in his *Pinax*, John Bauhine, and  
our

countrymen Gerard and Parkinson, and their contemporaries, as they wrote before the time that generical characters in botany were in use, included these lichens among the other herbaceous mosses, under the general name of *muscus*; adding to the name in general some epithet descriptive of its form, place of growth, or supposed virtue.

Mr. Ray, both in his History of Plants, and in the Supplement, as he was usually averse to the forming of new names, has interspersed them among other mosses, under the character of *musci steriles seu aspermi*, retaining the synonyms of the two Bauhines, Gerard, and Parkinson, to the general species.

Dr. Morison seems to have been the first, who separated them intirely from the herbaceous mosses; and, from the analogy he supposed they had with the fungus tribe, formed them into a genus, under the name of *musco-fungus*. He enumerates fifty species and upwards under this term in the *Historia Oxoniensis*, and has divided them into five orders, according to their different appearances, as follows:

1. *Musco-fungi e terra prominentes, latiores.* 5.
2. *Musco-fungi pixidati.* 11.
3. *Musco-fungi corniculati.* 26.
4. *Musco-fungi crustæ modo adnascetes.* 37.
5. *Musco-fungi corticibus arborum dependentes.* 53.

Table the 7th of his 15th section exhibits several good figures of some of these lichens.

Tournefort was the first, who adapted the generical term *lichen* to them; but it was in consequence of his joining them to the lichen of the shops. He has however excluded the coralline-mosses, and

forms them into a genus, by the name of *coralloides*; to which he has connected some plants, properly of the fungus tribe. In this distinction he is followed by Dr. Boerhaave in his *Index alter Plantarum*.

Dr. Dillenius first called them *lichenoides*, in the catalogue of plants growing about Gießen, chusing to retain the word *lichen* to the liverwort of the shops. Under this name however, in this work, he does not comprehend the *usneæ*, or hairy tree-mosses, but refers them to the *conserveæ*, adding the epithet *arborea* to each species, to distinguish them from the water kinds. He enumerates upwards of sixty species of *lichenoides*, but has applied few or no synonyms to them.

Under the same generic term he has introduced them into the third edition of Ray's Synopsis of British Plants, taking in the *usneæ*, and recounting upwards of ninety species, all found spontaneously growing in England. Many of these are undoubtedly only varieties. They are in this work very naturally divided into several orders and subdivisions, for the greater ease of distinguishing them, as follows:

caulifera	{	1. Capillacea et non tubulosa scutellata.	{	a. Solida et non tubulosa.
		2. Coralliformia tuberculosa plerumque.		b. Tubulosa.
		3. Pyxidata.		
		4. Fungiformia.		
Lichenoides	{	1. Mere crustacea.		
cauliculis destituta	{	2. Crusta foliosa scutellata seu foliis scutellatis arte adnascantibus -	{	a. Substantiæ ge- latinosæ.
				b. Substantiæ du- ris.
		3. Foliis magis liberis nec tam arte adnascantibus	{	a. Scutellatis et tuberculatis.
			{	b. Peltatis.

M. Vaillant, in the *Botanicon Parisiense*, retains Tournefort's names. Many of these lichens, as well as other mosses, are accurately represented in the elegant tables, which adorn that work. Dr. Haller  
tells

tells us he learnt to distinguish almost all the mosses solely by the help of these tables, so well are they expressed. The lovers of botanic science are greatly indebted to Boerhaave for his publication of that work.

Micheli, after Tournefort, adopts the term *lichen*, and comprehends all the species under it, except one or two, which he calls *lichenoides*. This author however does not take into this genus the liverwort of the *materia medica*; he describes the species of that genus under the name of *marchantia*. Near twenty of the plates in his *Nova Plantarum Genera* are taken up in representing various species of this genus. In this work they are divided into thirty-eight orders or subdivisions; a circumstance very necessary indeed, considering how greatly he has multiplied the number of the species. It is to be regretted, that so indefatigable an author, one whose genius particularly led him to scrutinize the minuter subjects of the science, should have been so solicitous to increase the number of species under all his genera: an error this, which tends to great confusion and embarrassment, and must retard the progress and real improvement of the botanic science.

Dr. Haller retains Micheli's term, and enumerates 160 kinds in his *Enumeratio Stirpium Helvetiæ*: he divides them into seven orders, according to the following titles:

1. *Lichenes corniculati & pixidati.*
2. *Lichenes coralloidei.*
3. *Lichenes fruticosi alii.*
4. *Lichenes pulmonarii.*
5. *Lichenes crustacei scutis floralibus ornati.*
6. *Lichenes scutellis ornati.*
7. *Lichenes crustacei non scutati.*

The extensive number of the species, and the difficulty of distinguishing them with a tolerable degree of certainty, has deterred Dr. Haller from adding so full and complete a list of synonyms to the plants of this genus as he has elsewhere done in that splendid work. Plate the 2d exhibits several elegant sorts of these lichens.

Linnaeus, and the followers of his method, who seem to have established their generical character from Micheli's discoveries, retain also his generical title. Micheli's passion for the multiplication of species is no-where more conspicuous than in the plants of this genus, which he has most enormously augmented to the number of 298 species. The Swedish professor cannot be charged with this foible: it is one of the excellencies of his writings, that they inculcate the reverse. He has so far retrenched this genus, that in his general enumeration of plants he recounts only eighty species belonging to it. They are in this work divided into eight orders, according to the difference of appearance which they form by their *facies externa*, little or no regard being had to what are usually called the parts of fructification.

- |   |                                 |
|---|---------------------------------|
| 1. <i>Lichenes leprosi tuberculati.</i> | 5. <i>Lichenes coriacei.</i>    |
| 2. <i>Lichenes leprosi scutellati.</i>  | 6. <i>Lichenes scyphiferi.</i>  |
| 3. <i>Lichenes imbricati.</i>           | 7. <i>Lichenes fruticulosi.</i> |
| 4. <i>Lichenes foliacei.</i>            | 8. <i>Lichenes filamentosi.</i> |

Dr. Dillenius, in his most elaborate work, intituled, *Historia Muscorum*, has divided this Michelian genus into three, under the names of *usnea*, *coralloides*, and *lichenoides*. Under the word *usnea* he comprehends the hairy tree-mosses, among which are the *usnea* of

the shops, and the true *usnea* of the Arabians. Of these he describes sixteen species. Under *coralloides* he describes thirty-nine species, among which are the cup-mosses, and many others, disposed according to the following scheme :

Ordo I. *Fungiformia, non tubulosa, nec ramosa*. 5.

Ordo II. *Scyphiformia, tubulosa, simplicia et prolifera*.

Series 1. *Scyphis perfectioribus*. 13. Cup-mosses.

Series 2. *Scyphis imperfectis*. 20. Horned mosses.

Ordo III. *Ramosa fruticuli specie summitatibus acutis multifariam divisis*.

Series 1. *Species tubulosæ*. 30. Tubulous coralline mosses.

Series 2. *Species solidæ*. 39. Solid coralline mosses; among which is the *orchel*.

The genus of *lichenoides* contains 135 species, disposed according to the following scheme :

Ordo I. *Species aphyllæ mere crustaceæ*. { 1. *Tuberculosæ*. 8.  
2. *Scutellatæ*. 18.

Ordo II. *Species foliosæ*. { 1. *Gelatinosæ tuberculosæ et scutellatæ*. 35.  
2. *Aridiores et exsuccæ, scutellatæ*. 100.  
3. *Aridiores peltatæ et clypeatæ*. 121.

These plants are not only largely described, and accompanied with the most perfect assemblage of synonyms; but every species is accurately figured, and many of them in various views, and at different ages of their growth; by which this laborious work, notwithstanding it is conversant upon the minutest, and con-

consequently the most abstruse parts of botany, may nevertheless be justly esteemed, without any exaggeration, one of the most complete works extant of the kind.

Dr. Hill, in his History of Plants, has disposed them into five genera, under the following names : 1. *Uşnea*, comprehending the hairy tree-mosses ; 2. *Platysma*, flat-branched tree-mosses, the lungwort, and others ; 3. *Cladonia*, containing the orchel and coralline-mosses ; 4. *Pyxidium*, the cup-mosses ; 5. *Placodium*, the crustaceous mosses.

The plants of this extensive genus are very different in their form, manner of growing, and general appearance : on which account those authors, who preserve them under the same name, saw the propriety and necessity of arranging them into different orders and subdivisions, that the species might be distinguished with greater facility. Upon the same principle Dr. Dillenius and Dr. Hill have formed them into several genera.

So far as the parts of fructification are distinguishable in these plants, they appear in different forms upon different species : on some, in the form of tubercles ; on others, in the form of little concave dishes, called *scutellæ* ; on others, of oblong flat shields or pelts. All these are conceived by Micheli and Linnæus to be receptacles of male flowers. The female flowers and seeds are suspected by the same authors to be dispersed in the form of farina or dust upon the same plants, and in some instances on separate ones. Dillenius has not dared to determine any thing positively with regard to the real parts of fructification in these lichens : time will hereafter, it is to be hoped, throw more light upon the subject.



In order to convey a more distinct idea of the several plants of this genus, which enter into æconomical or medical uses in the various parts of the world, we shall distribute them into several orders, according to the custom of former writers: and as is not consistent with our plan to describe each of these species, we shall refer to the page of the more modern authors, where they may be found.

## I. Lichenes filamentosi.

*Such as consist of mere solid filaments, of a firm and solid but flexible texture, having the appearance of fructification in the form of scutellæ, or flat round bodies growing from the sides or extremities of these filaments.*

This order or division comprehends the hairy tree-mosses, or *usnea* of Dillenius and Hill; several of the species of the fifth order of lichens of Micheli; and the *lichenes filamentosi* of Linnæus.

Dr. Dillenius describes sixteen species under the term *usnea*, several of which are found in England, tho' some of them, as the common *usnea* of the shops, but very sparingly, and none of them in any considerable plenty. The thick woods in many other parts of Europe, and the rest of the globe, afford them in great plenty. They hang from the branches of various kinds of trees, like large tufts of hair, to a considerable length: some species grow several feet long. The rocks on the tops of high mountains afford several kinds. They are of various colours; some whitish, ash-coloured, others grey or blackish, and two or three species have a yellow or orange hue.

The

The commentators in general agreed in making the *bryon* of (1) Dioscorides one of these hairy tree-mosses, which they called *usnea*. No wonder, therefore, that at the restoration of letters it became a matter of controversy, which of them was the *usnea* of the ancients. Dioscorides recommends his as an astringent; and tells us, that "the best grew upon the cedar; but that from whatever tree it was gathered, the whitest and most fragrant was preferable to the black." The several *usneæ* would undoubtedly in different countries be found upon different trees. In Italy, that of the larch-tree was the most odoriferous; and on that account Matthiolus (2) preferred it to all others. That kind, which at length obtained a place in the shops as the *usnea* of the ancients, was a species commonly found in our countries on old oaks and other trees, and is called by Dillenius (3) stringy tree-moss, or *usnea* of the shops. Many excellent virtues have been ascribed to it, on a supposition of its being the true *usnea*; but it does not appear to have deserved them: and the present practice, at least in England, has quite expunged it, and that perhaps very justly.

Dr. Dillenius is evidently of opinion however, that this common *usnea*, tho' it obtained a place in the shops as such, is not the *bryon* of Dioscorides and Pliny, or the *phascion* of Theophrastus, since he has

(1) Lib. i. c. 20. See this subject largely discussed in Bodæus à Stapel Comment. in Theoph. p. 156. et seq.

(2) Opera omnia à C. B. edit. 1598. p. 64.

(3) *Usnea vulgaris loris longis implexis* Hist. Musc. p. 56. *Lichen plicatus* Lin. Sp. Pl. 1154. *Muscus arboreus*: *Usnea* Officin. C. B. Raii Syn. III. p. 64.

applied these names from those fathers of botany to another species, which he calls the *beard usnea* (+). Nor does either of these species appear to be the true *usnea* of the Arabians, whatever title they may seem to have to it, either from their colour or smell. Belonius, as he is quoted by Dr. Dillenius, tells us, " that the true *usnea*, or *bryon*, as he calls it, is sold " at Constantinople under the name of *usnech*; and " tells us we are deceived in believing ours to be " the true *usnea*." Dillenius has therefore described another species (5), which he received from the East Indies, from Madagascar, and St. Helen's, as the *Usnea Arabum*. This plant the Indians call *saliaga*; and Camelli assures us, that, while fresh, it has a very fragrant musk-smell. He adds, that he had himself experienced what Serapio says of it; *viz.* that a vinous infusion of it restrains fluxes, stops vomiting, strengthens the stomach, and induces sleep.

The common *usnea* of the shops was said to be the basis of that fine perfumed powder, which the French called *corps de cypre gris*, and which formerly made a great article of trade at Montpellier. Dr. Brown hints (6), that the perfumers use it still; but he does not add, where. John Bauhine gives us the whole process (7) for making that power, which was vended in great quantities to all parts of France. It

(4) *Usnea barbata loris tenuilus floreſcis* Hiſt. Muſc. p. 63. *Li- che barbatus* Lin. Sp. Pl. 1155. *Quercus excrementum villoſum* C. B. p. 422. Bauhine took this to be the true *Usnea Arabum*.

(5) *Usnea ceratoides candicans glabra et odorata* Hiſt. Muſc. p. 71. *Muſcus arboreus candicans et odorifer* Camelli Raii Hiſt. III. Append. p. 3.

(6) Civil and Natural Hiſtory of Jamaica, p. 80.

(7) Hiſt. Plant. I. par. ii. p. 88.

is nevertheless true, that other of the lichens had as great a share in the composition as the *usnea*; as the demand for that powder could not have been answered, if the makers had confined themselves to the *usnea* alone. It was necessary too, inasmuch as other species are equally well adapted to the same uses (8).

This *usnea* is abundantly plentiful in the woods of Lapland; and Linnæus (9) relates, that the inhabitants apply it to their feet, when they are sore and excoriated with much walking. The benefit they receive from it in this case is undoubtedly owing to its styptic quality, which is remarked by Matthioli, and by Mr. Ray (10) from the German Ephemerides.

The *beard usnea* before mentioned, which is abundantly common upon the trees both in the northern regions of Europe and America, as well as in the eastern kingdoms, and is described by Mr. Ray as hanging to the length of two feet, the filaments of which are not thicker than a common thread, and of a greenish white colour, is used by the inhabitants of Pennsylvania to dye an orange colour with. This information Dillenius received from Mr. Bartram.

The black *mane usnea*, which grows in vast quantities in the Lapland woods, in a defect of the common coralline moss makes part of the fodder, and is equally acceptable to the rein-deer in the winter time (11).

(8) Flor. Lap. p. 342. s. Flor. Suec. Ed. II. p. 416.

(9) Flor. Lap. p. 348.

(10) Hist. Plant. L. p. 115.

(11) *Usnea jubata nigricans*. Dillen. Hist. Musc. p. 64. *Lichen jubatus* Lin. Sp. Pl. 1155. *Muscus corallinis saxatilis faniculaceus*, Rock-hair. Raii Syn. III. p. 65. n. 7.

The long beaded *usnea*, or necklace-moss (12), enters into the like œconomical uses in Virginia, where it is very plentiful. The inhabitants find it a very agreeable fodder in the winter season to both sheep and cows (13).

The Norwegians appropriate one of these *usnea* to a singular use. Pontoppidan tells us (14), "they have a certain kind of yellow moss hanging on the branches of trees of the firs and pines, which is very venomous, yet applied to a necessary use; for being mixed in pottage, or with flesh, as a bait for the wolves, they infallibly die of it." That the species here referred to is the brass-wired *usnea* of Dillenius (15), or the *lichen vulpinus* of Linnæus, cannot be doubted, since this last author mentions (16) the same application of it with very little variation. In England it is very rare; in Sweden plentiful, especially in the province of Smoland, where the natives dye woollen goods yellow with it.

John Bauhine describes a very beautiful species, under the name of *laricus muscus* (17), which gives a very elegant citron colour upon chewing, or upon maceration in water. Dillenius is doubtful, whether this is what he has described under the name of the orange-coloured forked *usnea* (18).

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(12) *Usnea capillacea et nodosa* Dillen. Hist. Musc. 50. *Muscus arboreus nodosus* C. B. p. 361. Raii Syn. III. p. 65. n. 4.

(13) Raii Hist. Pl. III. p. 28.

(14) Natural History of Norway, p. 148.

(15) *Usnea capillacea citrina frutriculi specie*. Hist. Musc. p. 73. *Muscus aureus tenuissimus* Merret. Pin. p. 79. Raii syn. p. 65. n. 8.

(16) Flor. Succ. Ed. II. p. 427.

(17) Hist. Plant. III. P. ii. lib. 9. p. 273.

(18) *Usnea dichotoma compressa segmentis capillaceis teretibus*. Hist. Muic. 72. *Muscus arboreus aurantiacus staminibus tenuissimis* Pluk. Alm. p. 254. Raii Hist. III. 28.

We may here observe by the bye, that the *usnea cranii humani*, which thro' the influence of superstition formerly obtained a place in the catalogues of the *materia medica*, does not belong to this division of the lichens. The writers of those times distinguished two kinds of *usnea humana*, under the names of *crustacea* and *villosa*. Any of the crustaceous lichens, but more properly the common grey-blue pitted *lichenoides* of Dillenius, was used for the former of these; and, as Dale tells us, was held in most esteem. The *villosa* was a species of the genus of *hypnum*. Indeed it does not appear, that they were in those days very curious in determining the exact kind; and doubtless any moss, which happened to grow upon an human skull, was sufficient for the purposes designed.

## 2. Lichenes fruticulosi.

*Such as consist of a tough flexible matter, formed into ramifications, in some species almost simple, in others resembling small shrubs: in some of the species the branches are quite solid, in others tubular.*

This order comprehends the third of Dillenius's genus of *coralloides*; the whole *cladonia* of Hill; the second, and several species of the third order of Haller's lichens; several species of the fifth, and the whole sixth, order of Micheli; and the *lichenes fruticulosi* of Linnæus.

The plants of this genus grow principally upon the ground on heaths, forests, and mountainous bar-

ren places; except the *orella*, or Canary-weed, which is found upon the rocks on the sea-coast.

To this division belongs the horned moss (19). It is found with us in rocky barren ground, and upon old walls not uncommon. It was formerly in great credit as a pectoral; but is now quite in disrepute.

The common branched coralline-moss (20) is one of the most useful plants of all the tribe of lichens. It is pretty frequent with us on our heaths, forests, and mountains. The northern regions afford it in abundance; and there it is peculiarly and singularly useful. It is indeed the very support and foundation of all the Lapland œconomy, and without which the inhabitants could not sustain their rein-deer in the winter time. Linnaeus tells us (1), that Lapland affords no vegetables in such plenty as this, and other of the lichens. Plains of several miles extent are totally covered over with it, as if with snow; and where no other plant will even take root, this will thrive and be luxuriant. These dreary and inclement wastes, these *terreæ damnatæ*, as a foreigner would readily call them; these, are the Lapland fields and fertile pastures. On this lichen the rein-deer, those sources of all their wealth, feed in the winter time, when it is in its most flourishing condition, and no

(19) *Coralloides corniculis longioribus et rarioribus*. Dillen. Hist. Musc. p. 103. *Muscus corniculatus* Ger. p. 1372. Park. 1308. Raii Hist. I. p. 112. III. p. 28. *Lichensides tubulosum cinereum n. n. crustaceum minusque ramosum* Raii Syn. 3. p. 67.

(20) *Coralloides montanum fruticuli specie ubique candicans* Hist. Musc. p. 107. *Lichen rangiferinus* Lin. Sp. Pl. 1153. *Muscus corallinus*. Tab. Ger. em.

(1) Flor. Lappon. p. 332.

other vegetable is to be had : with this too they will even become fat. The riches of the Laplanders consist in their number of these cattle : they are clothed with their skins, fed with their flesh, and from their milk they make both butter and cheese. Nature, by the inclemency of their seasons, has almost denied them the cultivation of their earth : they neither sow nor reap ; but live a perpetual migratory life, tending their flocks of rein-deer, upon which their whole care is centered and employed.

The milk of the rein-deer is very remarkably fat and rich : it tastes indeed like cow's milk, with which some butter, and a small quantity of fat or suet, has been intimately united. Dr. Haller (2) suspects, that this richness of the milk is owing to the animals feeding upon this moss. Most of the plants of this family are of an astringent quality, which indeed they manifest to the taste. This astringency of their food will doubtless contribute much to that effect.

The rein-deer are not the only animals that will feed upon the coralline moss. The Novaccolæ (3) gather vast quantities of it to fodder their oxen with in the winter. They take the opportunity of raking it together in the rainy seasons, when it is tough ; for in dry weather it easily crumbles into powder. This they moisten with a little water in the winter season when they use it, and find it excellent fodder.

(2) Enum. Stirp. Helv. p. 69. N°. 38.

(3) The Novaccolæ are a people originally sprung from the Finlanders : they fixed themselves in Lapland not long since, and traffick with the old inhabitants.



The coralline mosses are subject to great variation : and altho' there are several really distinct species, yet they run so into one another, that it is no easy matter to fix upon the real specific distinctions, in many instances. Some species are perfectly white ; others have the extremities of the branches reddish, some brown, and others almost black. The common coralline moss in Lapland not unfrequently grows to be several inches long, and even a foot high.

The tubular or hollow branched coralline mosses are not the only kinds upon which the rein-deer will feed. Almost all the lichens are abundantly more plentiful in those northern, than in these more southerly climates. There are several species with solid branches ; one, which Dillenius calls *The crisp warty Alpine coralloides* (4), which is almost as plentiful as the common sort, and is equally acceptable to those animals (5). It was before observed, that, in defect of these mosses, the black *mane usnea* is a substitute equally acceptable to those animals.

Another of the most remarkable and useful plants of this division is the *orcbel* (6), or *argol*, as it is

(4) *Coralloides crispum et botryforme Alpinum* Hist. Musc. p. 114. *Lichen paschalis* Lin. Sp. Pl. *Lichenoides non tubulum cinereum ramosum totum crustaceum* Raii Syn. III. 66. N. 11. This moss is not common in England. Dr. Dillenius found it upon some of the mountains in Wales. It is found in many places on Charley-forest, Leicestershire.

(5) Flor. Lappon. N°. 489.

(6) *Coralloides corniculatum fasciculare tinctorium fuci teretis facie* Dillen. Hist. Musc. p. 120. *Cladonia tophacea* Hill. Hist. Pl. p. 93. *Fucus capillaris tinctorius* Raii Hist. I. p. 74. *Lichen (Rocella) fruticulosus solidus aphyllus subramosus tuberculis alternis* Lin. Sp. Pl. 1154.

commonly

commonly called. This enters more into œconomical uses among us than any other of the whole genus. How considerable an article it forms in the dying trade, in which its uses are various and extensive, is very well known. Its tinging property has been known from ancient times; and some of our most celebrated botanic writers are of opinion, that it was used as a dye even in the days of Theophrastus. That father of botany mentions a *jucus*, which, he says, grew upon the rocks about the island of Crete; and that they dyed woollen garments of a purple, or rather a red colour, with it. It grows on the rocks by the sea-coast in many parts of the Archipelago, and in the Canary Islands; from whence we generally import it, as well as from the Cape Verd, which afford it in plenty. The demand for *orchel* is so great, that Mr. Hellot (7), of the Royal Academy of Sciences, informs us, they gather yearly, upon an average, from the isle of Teneriffe 500 quintals, which amounts to 25 ton weight; from the Canary Islands 400 quintals, from Forteventura 300, from Lance-rota 300, the same from Gomera, and from Ferro 800.

The way of manufacturing the *orchel* for the uses of dying, was for a considerable time a secret in few hands; but it is now done in London, and other parts of Europe, to great perfection. Mr. Ray, from Imperatus, gives a brief account of the process (8). Micheli has since delivered a more exact detail of it.

(7) L'Art de la Teinture des lains et des Etoffes de lain, Paris 1750, p. 543.

(8) Raii Hist. Plant. I. p. 74.

His, at least, seems to be the method (9), which the dyers at Florence used. From both these accounts, urine and pot-ash appear to be the principal ingredients used in extracting its colour.

Many other plants of this genus contain the same tephaceous matter as the *orchel*; and upon trial have been found to strike a good colour. Micheli, after he has related the preparation of the *orchel*, suggests the same thing; and M. Hellot, in the treatise before mentioned, tells us, there are many other mosses, which will give as good a colour as the *orchel*. In fact, he adds, that M. Bernard de Jussieu brought him some from the forest of Fontainebleau, which, upon experiments with urine and lime, took a purple colour. In the sequel of this memoir we shall point out some of these kinds. M. Hellot has given us a process, which he made use of for discovering whether any of these lichens would yield a red or purple colour. It is as follows: "Put about  
 " two drachms of any of these lichens into a little  
 " glass jar: moisten it well with equal parts of  
 " strong lime-water, and volatile spirit of *sal ammo-*  
 " *niac*: tie a wet bladder close over the top of the  
 " vessel, and let it stand three or four days. At the  
 " end of this time, if the lichen is likely to answer,  
 " that small quantity of liquor, which you will find  
 " in the glass, will be of a deep crimson red; and  
 " the plant will retain the same colour when the li-  
 " quor is all dried up. If neither the liquor nor the  
 " plant have taken any colour, it is needless to make  
 " any further trials with it." This process is simple

and easy, and well worth observation by all who are disposed to prosecute experiments of this nature : and indeed it is worth the trial, whether several lichens, which we have plentifully enough in England, would not answer in this respect.

### 3. Lichenes pyxidati.

*Such as consist of a firm tough flexible matter, formed into simple tubular stalks, whose tops are expanded into the form of little cups.*

This division contains the cup-mosses of authors ; the second order of *coralloides* of Dillenius ; great part of the first order of lichens in Haller ; the 7th, 8th, 9th, and 10th order in Micheli ; and the *lichenes schyphiferi* of Linnæus. Dr. Hill has constituted a genus intirely of these cup-mosses, under the name of *pyxidium*.

They are common with us on heaths, and other dry and barren places. Some of them are proliferous, even to the third degree, and form a very beautiful appearance. Some have tubercles on the edges of the cups, of a beautiful scarlet colour.

The cup-moss (10) was a long time in great and established use for coughs, and especially for the whooping cough in children ; for which it was long accounted a specific. To this end it was given in various forms. Gerard and Parkinson recommend

(10) *Coralloides schyphiforme tuberculis fuscis* Hist. Musc. 79.  
*Lichenoides tubulosum pyxidatum cinereum.* Raii Syn. III. p. 68.  
*Pyxidium margine leviter serrato.* Hill. Hist. Plant. p. 94.

the powder to be taken for several days together. Dr. Willis was particularly one of its patrons. He has given us (11) several forms for its exhibition, as that of the powder, a decoction, and a syrup from it.

The present practice has quite exploded it, and very justly perhaps, as in any degree specific in the above disorder. Nevertheless, it seems to have sustained that character with as great a reputation, and perhaps with as good a title to it, as almost any of the specifics of that age. It has been observed before, on another occasion, that this tribe of mosses have in general an astringent property; as such, the cup-mosses are consequently of a strengthening nature: it is no wonder, therefore, that they should be helpful in this disorder, merely as corroborants. That they were useful in some measure can scarcely be doubted; and our very eminent Dr. Huxham (12), in treating upon this obstinate complaint, seems to allow this of the cup-moss in preference to other idle specifics. Happily for us, the Peruvian bark supplies a remedy of infinitely more use, where such analeptics are required.

Dr. Lister, in some ingenious observations of his, printed in the Philosophical Transactions (13), touching colours and dyes, observes, that the scarlet heads of these mosses, upon the affusion of lye, will strike a purple which will stand.

(11) Willis Pharm. Rational sect. I. cap. 6. *de tussi puerorum convulsiva*.

(12) De Aëre et Morbis epidemicis, p. 76, 77. vol. I.

(13) Lowthorp's Abridgment, vol. II. p. 660.

## 4. Lichenes crustacei.

*Such as consist of a dry and friable matter, more or less thick, formed into flat crusts, very closely adhering to whatever they grow upon.*

Some of the species of this division consist of an exceeding fine thin crustaceous, or rather, as Micheli calls it, farinaceous matter, the fructifications appearing in the form of tubercles. Others consist of a thicker scabrous crust, having the fructifications in the form of little cups, called *scutellæ*.

This division contains the first order of the *lichenoides* of Dillenius; the 5th, 6th, and 7th orders of Haller's lichens; the *lichenes leprosi* and *crustacei* of Linnæus; and several of the *placodium* of Hill.

The species are numerous, and most of them very common on rocks, stones, old walls, the bark of trees, old pales, &c. which are commonly covered over with them, in undisturbed places. They form a very agreeable variety, and some of them have a very elegant appearance.

Dr. Dillenius describes a species of this order, which he found upon the tops of the mountains in Caernarvonshire in Wales; and which the inhabitants told him they used as a red dye, and found it preferable to the cork, or arcel, which they call *kenkerig*. He has intitled it, in English, *The white tartareous scarlet-dying lichenoides* (14). He is of opi-

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(14) *Lichenoides tartareum tinctorium candidum tuberculis atris.*  
Hist. Musc. p. 128.

mon, that this is the moss which Martin mentions, in his account of the Western Islands of Scotland, under the name of *corkir*; with which the inhabitants of the island of Sky dye a scarlet colour. They prepare it by drying, powdering it, and then steeping it for three weeks in urine. Linnæus queries whether this moss be not the same as his *lichen calcareus* (15); a species so peculiar to limestone rocks, that where-ever that stone occurs among others, it may be distinguished at the first view by this moss growing upon it. This is a singularity which Dr. Dillenius has not mentioned in his moss: on the other hand, Linnæus does not mention any tinging property in his.

The *gèrèle d'Auvergne*, or *oreille de terre*, of the French, belongs to this order of lichens, and is called by Dillenius (16) *The crayfish-eye-like lichenoid s.* It is gathered in large quantities in the province of Auvergne, and is used as *orchel*; to which however it is greatly inferior. They prepare it with lime and urine; and were acquainted with its use as a dye long before the Canary weed was known (17) to them; and it is at this day in more common use than the *orchel*. We have it frequent with us upon old walls, rocks, and stones; but it is to be had in larger quantities in several other parts of Europe.

(15) *Lichen (calcareus) leprosus candidus tuberculis atris* Spec. Part. II 40

(16) *Lichenoides leprosum tinctorium scutellis lapidum Caneri figura* Hist. Musc. 130. *Lichenoides crustaceum et leprosum scutellare ciliatum* Rad. Syn. p. 70.

(17) Tournefort's Voyage to the Levant, Eng. edit. Lond. 1742. in 8<sup>o</sup> vol. I. p. 248.

The mealy tartareous *lichenoides* (18) with brown dishes, forms an article of trade with the people of West Gothland. They manufacture a beautiful red dye from it, which they sell under the name of *lyst-telet* (19). Dr. Hill says we have this moss abundantly in Leicestershire and Warwickshire.

The Welch make a red dye, with urine, from another moss of this order, which Dillenius describes (20) by the name of *The large leprous lichenoides with yellow plates*. These are not the only species, which are endowed with a tinging quality: other kinds have been observed to give a red or purple colour to paper in which they have occasionally been inclosed. Doubtless several would, upon sufficient trials, be found to answer equally well with the *orchel*.

With regard to these crustaceous mosses in general, it is highly worthy our regard, that in the œconomy of nature they answer singular and important uses. To an unobserving eye, no class of vegetables may appear more insignificant, or less adapted to advantageous purposes in the creation, than these. This vulgar estimation of things is frequently erroneous; and it is certainly so in the instance before us. These minute and seemingly insignificant mosses serve, under some circumstances, to valuable purposes. No sooner is a rock left bare by the sea, but these lichens lay the foundation for its future fertility. Their seeds,

(18) *Lichenoides tartareum farinaceum scutellarum umbone fusco*. Hist. Musc. 132. *Placodium bracteis majusculis limbo albo cinetis* Hill. Hist. Pl. p. 97.

(19) Flor. Suec. Ed. II. p. 407.

(20) *Lichenoides crustaceum et leprosum acetabulis majoribus luteis limbis argenteis* Raii Syn. p. 71. N. 46. Hist. Musc. p. 132.



which are presently brought thither by the winds, soon cover it all over. These corrupting, presently afford a soil sufficient to nourish other smaller mosses; which, in their turn, form one deep enough for larger plants and trees; and thus the rock becomes a fertile island (21).

### 5. Lichenes foliacei scutellati.

*Such as consist of a more lax and flexible matter, formed into a foliaceous appearance, having the parts of fructification in the form of scutellæ.*

Some of the plants of this division are interspersed with the former in some of the systems of botanic authors. In general this division contains the whole first series of the second order of *lichenoides* in Dillenius; the first division of the second series, and the latter part of the second division, of the same: it comprehends the *lichenes imbricati* and *umbilicati* of Linnæus; and many of the *placodium* of Hill.

The plants of this order are many of them not less common in England than the foregoing, on rocks, stones, old pales, trees, &c. Some adhere very closely to what they grow upon, and seem to be only foliaceous about the edges: others adhere but loosely, and are much expanded and divaricated, so as to form something like ramifications.

It was remarked, from Linnæus's observation, that one of the crustaceous lichens was scarcely ever found growing but upon limestone rocks. On the contrary,

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(21) Vide Œconom. Natur. in Amæn. Acad. vol. II. p. 17.  
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the same author has observed of a foliose lichen belonging to this order, that it will thrive on all kind of rocks but limestone rocks. This species (1) Dillenius calls *The common grey-blue pitted lichenoides*. It is very common with us upon trees, old wooden pales, &c. as well as upon rocks and stones. It is the *usnea cranii humani* of the old *materia medica*. Linnæus adds, that it will dye a purplish colour.

Hither likewise must be referred the cork or arcel (2), which is used by the Scotch, and others, to dye a purple or scarlet colour. The preparation of it is by powdering, and making it into a mass with urine. Parkinson tells us (3) the poor people in Derbyshire scrape it from the rocks, and make the same use of it. Mr. Ray (4) adds to this account, that the Welch, who call it *kenkerig*, have long been acquainted with this property, and have it in common use. The colour from this moss is but very dull; but if the same methods were taken to improve it, as have been with the *orchel*, it would undoubtedly be rendered much better, and more durable. Linnæus relates (5), that there is an immense quantity of this moss about the rocks of the

(1) *Lichenoides vulgatissimum cinereo-glaucum lacunosum et cirrosum* Hist. Musc. p. 88. *Lichenoides crusta foliosa superne cinereo-glaucæ, inferne nigra et cirrosa scutellis nigricantibus*. R. Syn. p. 72.

(2) *Lichenoides saxatile tinctorium foliis pilosis purpureis* Raii Syn. p. 74. N<sup>o</sup>. 70. Hist. Musc. p. 185. *Lichen petræus purpureus Derbiensis* Park. Theat. p. 1315. *Lichen omphalodes* Lin. Spec. Pl. 1143.

(3) Park. Theat. Botan. p. 1315.

(4) Raii Hist. Plant. p. 116.

(5) Flor. Lappon. p. 343. V.

isle of Aland in the Baltick; where the good women themselves make a yellow dye with it from a simple decoction of the plant, without the addition of any saline article. He adds, that those, who would heighten the colour, add a small quantity of *roucou* (\*) to the decoction.

Professor Linnæus tells us, that the Gothlanders manufacture a yellow dye from the common curled *lichenoides* with yellow leaves and plates (6). He adds, that it is a celebrated medicine in the esteem of the country people, as a specific in the jaundice (7). Helwingius, in the Supplement to the *Flora Prussica*, affirms, that this moss will tinge paper and linen of a lively carnation colour, which too will stand the test of being exposed to the open sun for a long time without fading. It seems very probable, however, that he must mean some other plant of this genus, as Dillenius tells us he made the experiment unsuccessfully.

Sweden affords a moss of this order, which, as far as hitherto appears, seems to be unknown to former botanists, and which Linnæus says will dye a deep purple colour (8).

(\*) Otherwise called *arnotto*.

(6) *Lichenoides vulgare sinuosum foliis et scutellis luteis*. Hist. Musc. p. 180. *Lichenoides crusta foliosa scutellata flavescens*. Rati Syn. p. 72. N°. 59.

(7) Flor. Suec. Ed. II. p. 416. N°. 1093.

(8) Linnæus has intitled this moss *Lichen (flygius) imbricatus, folio is palmatis incurvis atris*. Fl. Suec. I. 949. Spec. Plant. 1143. Fl. Suec. II. N°. 1079.

6. *Lichenes erecti ramosi plani.*

*Such as consist of a firm tough matter, disposed into flat and thin ramifications growing erect, and bearing their scutellæ upon the edges, surfaces, and at the extremities.*

This division comprehends the flat branched tree-mosses of authors; many of the fourth order of Haller's lichens; the first part of the second division of series the second in Dillenius; and the *platisma* of Hill.

The plants of this division grow upon old trees, especially in thick and unfrequented woods; some of them upon rocks: they are many of them extremely common in England upon all kinds of trees. As they were some of the most obvious, so they were some of the first lichens noticed by the old writers, by whom they were called *lichenes arborum*.

The mosses of this order were substituted in the room of the *usnea* in the composition of the *pulvis cyprius*. The very species, which was most frequently used for this purpose, was the channel-leaved *lichenoides* of Dillenius (9), on account of its being easily reduced into a fine powder, of a good white colour. Nevertheless, others are undoubtedly as well adapted to the same purposes: and, if it was of importance

(9) *Lichenoides coralliforme rostratum et canaliculatum*. Hist. Musc. 170. *Lichenoides arboreum ramosum angustioribus cinereo-virescentibus ramulis*, Raii Syn. 75. *Lichen calicaris* Lin. Spec. Plant. 1146.

enough to employ them to any purposes of the like nature in our own country, they might be procured in sufficient plenty.

One of the plants of this order is applicable to the same uses as the Canary-weed, and is reckoned not much inferior to it; and as it is found in the same places, it is very often packed up with it in considerable quantities. Dillenius calls it *The flat dyers lichenoides with longer and sharper horns* (10). It is truly and properly a plant of the lichen genus, tho' the older writers of the last century called it a fucus. They were led into this mistake by its having flat ramifications, and from its growing on the rocks by the sea side. It is found in the East Indies upon trees, and is frequent on the coasts of the Mediterranean, as well as about the Canary Islands.

## 7. Lichenes peltati.

*Such as consist of a tough or coriaceous matter, disposed into a foliaceous appearance; on the edges of which, in general, the parts of fructification are placed, in the form of flattish oblong bodies, in these mosses called shields or pelts.*

This division contains the third series of the second order of Dillenius's *lichenoides*; the *lichenes coriacei* of Linnæus; and several of the *placodium* of Hill.

That celebrated and well-known plant, the ash-

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(10) *Lichenoides fuciforme tinctorium corniculis longioribus et acutioribus*. Hist. Musc. 168. *Platysma corniculatum*. Hill Hist. Plant. 30. *Lichen fuciformis* Lin. Sp. Pl. 1147.

coloured ground liverwort (11) of Ray belongs to this order. It is very common all over England on dry and barren ground ; and indeed almost all Europe, and America too, seems to afford it in sufficient plenty, as we find it observed by almost all the the botanic writers since Ray, who was one of the first that described it.

The earliest account we have of its use for the bite of a mad dog is in the Philosophical Transactions (12), from Mr. Dampier, in whose family it had been a secret for a number of years. It was communicated first to Sir Hans Sloane, as a kind of fungus, or Jew's-ear ; and, at the request of Dr. Mead, was some years afterwards received into the London dispensatory. Scarce any of the boasted specifics of former ages ever acquired so great reputation as this plant has done in modern times, for its prevalence against the bite of a mad dog ; and the patronage of the late learned Dr. Mead made it sufficiently known throughout all the world. Happy would it be indeed, if it fully deserved the high encomiums, which have been bestowed upon it. A great and eminent physician (13) has doubted its efficacy at all in such cases ; and it is well known, that Boerhaave even laughed at it. Dr. Mead had certainly an high opinion of it : he tells us it never failed, thro' the course of thirty years experience, where it was duly given

(11) *Lichenoides digitatum cinereum lactucae foliis sinuosis* Dillen. Hist. Musc. 200. *Platysma sinuosum scutellis ovato-rotundis* Hill Hist. Pl. 89. *Lichen caninus* Lin. Sp. Pl. 1149.

(12) See Lowthorp's Abridgment, vol. III. p. 284.

(13) Dr. Van Swieten. See Comment. in Boerh. Aphor. §. 1147.

before the *hydrophobia* came on (14). Later instances have shewn, that it is not infallible; and Dr. Van Swieten's supposition is but too likely to prove true. It must be confessed, that Dr. Mead's exhibition of it seems too much complicated with other means to leave room for judging fully of its real efficacy; and it may really be questioned, whether bleeding, pepper, and cold-bathing, have not had more to do in the case than the lichen.

The *muscus pulmonarius officinarum* (15), tree-lungwort, or oak-lungs, belongs to this order. It is found about old oaks, and upon rocks and stones overgrown with moss, in many of our thick woods in England; but not in any great plenty.

Few, perhaps, of the antiquated simples were in more repute, in their day, than this plant. It was celebrated for ages, on account of its supposed prevalence in pulmonary complaints of almost all kinds; and yet, upon inquiry into the original of its use in such cases, it would probably appear, that it arose more from a fancied resemblance they found in the plant to the lungs themselves, than from any real and well-grounded proofs of its efficacy. As a gentle astringent, like most other species of the family, it would doubtless contribute to relieve in many cases where the lungs were affected, as in *kæmoptöcs*, and some others: but it does not seem, by any means, to deserve that high character in medicine which has been given to it.

(14) Mechanical Account of Poisons, ed. 4th, p. 156.

(15) *Lichenoides pulmonium reticulatum vulgare marginibus peltatis* Dill. Hist. Musc. 212. *Lichenoides peltatum arboreum maximum*. Rai. Syn. p. 76. *Musc. pulmonarius* C. B.

The people in Herefordshire, where this moss is called *rags*, dye their stockings of a brown colour with it. This is done by a very strong but simple decoction in water, and the colour stands well (16).

The fine green *lichenoides* with black warts (17), is a celebrated medicine, and in very frequent use, with the country people about Upsal, for the thrush in children: to this end they give an infusion of it in milk. A medicine of this kind is of great importance in those countries, where that disorder occurs much more frequently than with us (18). It is not received into the Swedish dispensatory; but is known however in the shops, under the name of *muscus cumatilis*. We have it not in England; and Dillenius found it but in one place about Geissen: in the woods of Sweden it is more plentiful. A singular case, which is related in the *Amœnitates Academicæ* (19), has given rise to an opinion of its usefulness in the worms also. The case briefly was this: A country girl had, for near half a year, complained of excruciating pains in her stomach and bowels, which were attended with vomiting, anxiety, and great watchfulness. All that had been prescribed for her by Professor Linnæus and others, who took her case for the worms, proved altogether fruitless. Being afterwards left to the care of her neighbours and relations, some good women gave her a decoction of this moss, which the Uplanders call

(16) Dillen. Hist. Musc. p. 213.

(17) *Lichenoides digitatum læte virens verrucis nigris notatum.*  
Ibid. p. 207.

(18) Boerhaav. Aphorism. §. 982.

(19) Vol. II. p. 69. *De Tœnia.*



*elfnesfer.* After she had taken it a few days, she vomited up six or seven roundish worms, and was cured. These were found, upon examination, to be the maggots of a kind of brown bee-fly, described by Mr. Ray (20), and by Linnæus (1).

However insufficient this history may be, to prove the usefulness of this plant as a vermifuge, it will at least serve to exemplify this fact; namely, that other animals of the insect kind, besides the *teniæ*, *lumbrici*, and *ascarides*, may subsist a long time in the *primæ viæ* of the human body, and be the cause of great disturbances therein (2).

Necessity is frequently the parent of the most useful and important discoveries: and the uses to which a plant of this order is appropriated by the natives of Iceland, is a standing proof of the truth of this observation. That climate will scarcely permit the cultivation of any kind of grain; but the want of it is in a great measure happily supplied by the eryngo-leaved *lichenoides* (3), which is abundant in the northern regions; and in that island particularly the natives have long been acquainted with the methods

(20) *Musca apiformis, tota fusca, cauda obtusa, ex ejula caudata in latrinis degente orta.* Raii Hist. Insect. p. 272.

(1) Faun. Suecica, N°. 1084.

(2) See two cases nearly of this kind observed by Dr. Lister. Lowthorp's Abridgment, vol. III. p. 135.

(3) *Lichenoides rigidum eryngii folia referens* Dillen. Hist. Musc. p. 209. Raii Syn. p. 77. *Lichen foliis oblongis laciniatis marginibus conniventibus ciliaribus.* Flor. Lappon. Hall. Helv. 75. *Lichen (islandicus) foliaceus adscendens laciniatus marginibus elevatis ciliaribus* Lin. Flor. Suec. I. 959. II. 1085. Mat. Med. N°. 493. Spec. Plant. 1145.

of applying it both to the purposes of food and of phyfic.

Ray has long since informed us (4), from Bartholine, that in the spring time, while it is young, it will purge, in consequence of which it is used as common spring phyfic. This quality it loses in a short time; and what serves for phyfic in the spring, is converted the remaining part of the year into food. They collect large quantities of it, grind it into meal, and make both pottage and bread of it. It is in common use not only with the islanders, but in several parts of Sweden also, where it is found to be a very appropriate diet in phthical cases (5). These accounts of the excellent use of this lichen correspond perfectly well with the last accounts of it in Mr. Horrebow's Natural History of Iceland, just published; and which I shall take the liberty of transcribing as follows: "There is another herb, "  
 " called *muscus catharticus islandiæ* or mountain-  
 " grass, which they cook up into a delicate dish. I  
 " have often eat of it; at first out of curiosity, but  
 " afterwards for its palateableness and wholesomeness.  
 " The excellent qualities of this herb are described  
 " in the Memoires of the Society of Arts and Sci-  
 " ences in Sweden. It grows in great abundance;  
 " and those that live near the places, where it is  
 " found, gather great quantities for their own use,  
 " and to send to market. People that live at a  
 " great distance will send and fetch horse-loads  
 " away. Many use no meal or flour at all, when

(4) Raii Hist. Plant. p. 114.

(5) Flor. Lappon. N°. 445.

“ they are stocked with this herb, which in every respect is good and wholesome food” (6).

This moss is not very common in the southern countries of Europe. England affords it but very sparingly. Mr. Newton and Dr. Dillenius found it in Wales; Sibbald, in Scotland. It is frequent on the Alps of Switzerland; and Dr. Haller mentions it in his *Iter Hercynium*. Sweden and Lapland have it in plenty: and on account of its great abundance and usefulness in Iceland, Bartholine, and after him others, called it *muscus islandicus*.

#### CONCLUSION.

I cannot help remarking, by way of conclusion, that we have in this genus of plants a convincing instance of the utility which may result from the study of natural science in general, and even of its minuter and hitherto most neglected branches. From a view of the foregoing memoir it is evident, I presume, that the œconomical uses of the lichens, in the various parts of the world, are already very considerable and important: and altho' it does not appear, that the sensible qualities of any of them, or the experience of former ages, will warrant our ascertaining any singular powers to them in a medicinal way, yet posterity will doubtless find the means of employing them to many valuable purposes in human life to us unknown.

It will at once be acknowledged, that the vegetable kingdom supplies us with the far greater share of the

'6) Horrebow's Natural History of Iceland, p. 36.

necessaries,

necessaries, the conveniencies, and even the elegancies,  
 of life. The cultivation of that knowlege, which  
 leads to the investigation of its subjects, cannot,  
 therefore, but be highly useful and necessary: and  
 altho' the bare science of natural knowlege is of it-  
 self worthy of applause, yet it ought to be confi-  
 dered, in reality, as the necessary means only of ap-  
 plying the subjects of nature's kingdoms to their true  
 ends and purposes, the service of mankind. To know  
 and distinguish, by determined and specific charac-  
 ters, even but a small share of that amazing multi-  
 tude of objects, with which the great Parent of na-  
 ture has furnished our globe, is a task far more than  
 equal to the duration of human life. To investigate  
 and ascertain their various qualities and uses is equally  
 arduous and impracticable. While the naturalists,  
 therefore, are employed in distinguishing the forms  
 of things, let others exert the united efforts of genius  
 and application to investigate their various properties  
 and uses. I need not say the field for both is bound-  
 less: it doubtless will be so for ages yet to come.  
 The hopes of discovering some latent property, which  
 may turn out to the advantage of his fellow creatures,  
 will animate the man, whose mind is truly formed  
 for relishing the pleasures of natural science; and  
 however the result may be, the inspection and con-  
 templation of nature's productions will ever afford  
 that satisfaction, which will amply repay him for his  
 trouble. The minuter, and, as they are commonly  
 estimated, the most abject and insignificant things  
 are not beneath our notice; and an attentive mind  
 will readily conceive how much farther, and more  
 extensively useful, every branch of nature's kingdom  
 may

may yet prove in the œconomy of human life. The man, therefore, whom a genius and love for natural history has allured into its pursuits, and whose leisure permits his gratification in such researches, if he is not happy enough to be crowned with success, at least deserves it, and merits the thanks of his fellow-creatures for his application and diligence.

XCII. *An Account of the fossile Bones of an Allegator, found on the Sea-shore, near Whitby in Yorkshire. In a Letter to John Fothergill, M. D. from Capt. William Chapman.*

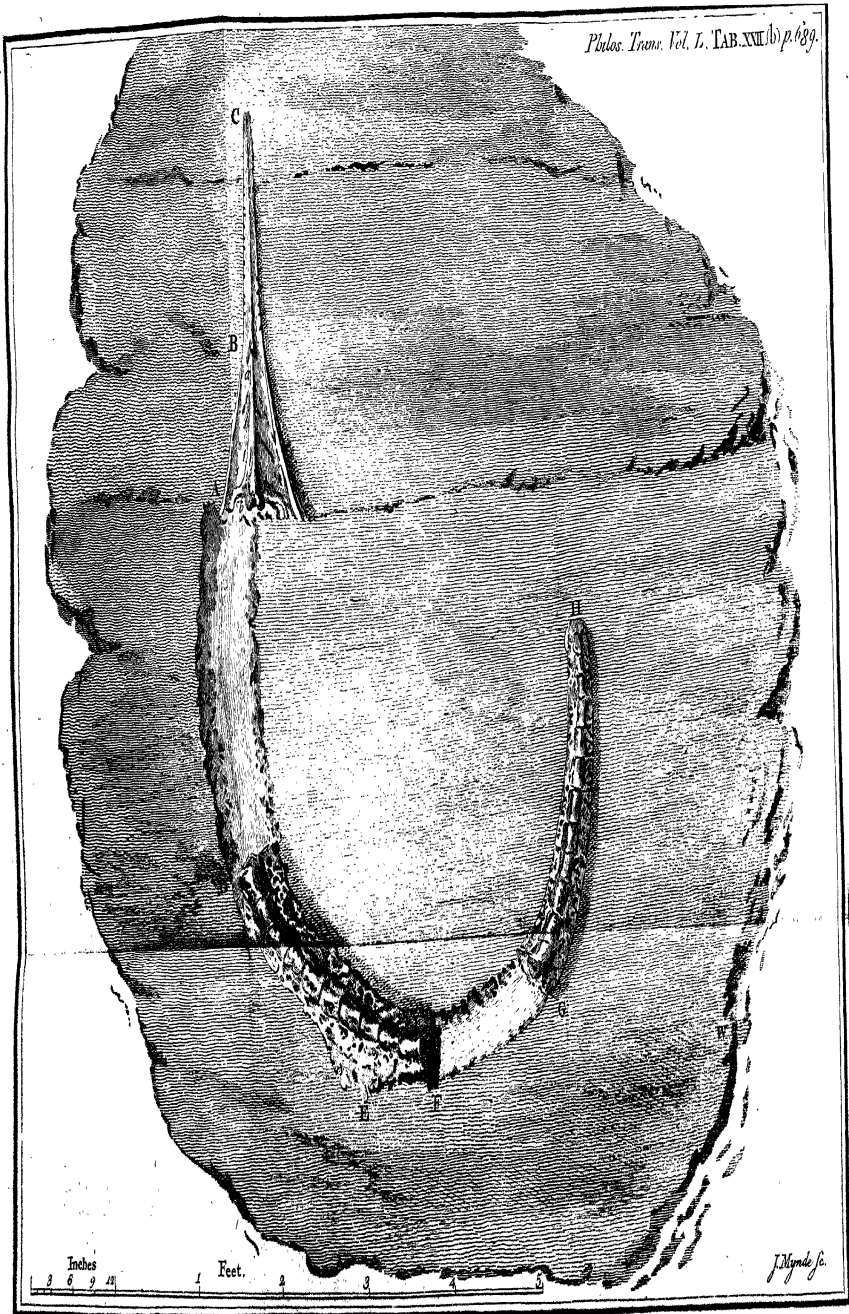
Whitby, 20th of 1st mo. 1758.

Read May. 4.  
1758. **A** Few days since we discovered on the sea-shore, about half a mile from this place, part of the bones of an animal, appearing as in the annexed figure (*See TAB. XXII.*). The ground they laid in is what we call allum-rock; a kind of black slate, that may be taken up in flakes, and is continually wearing away by the surf of the sea, and the washing of stones, sand, &c. over it every tide.

The bones were covered five or six feet with the water every full sea, and were about nine or ten yards from the cliff, which is nearly perpendicular, and about sixty yards high, and is continually wearing away, by the washing of the sea against it; and, if I may judge by what has happened in my own memory,









are visible and deep, and at the same distances from each other as the teeth in the other part of the jaw. The tip or extremity of the bill was entire for four or five inches, having both *maxillæ*, with their teeth, and towards the point large fangs. Part of the bill and head were covered with the rock; which was removed before they appeared as in the figure.

*A, D, F, G*, cavities in the rock, about two inches deep, where, I suppose, the wanting *vertebræ* have laid, as they are exactly suited to have received them.

*D, F*, Ten *vertebræ*, from three to four half inches in diameter, and about three inches long, some of them separated in taking up. They were about two inches in the rock.

*E*. Here we observed something like bone to stretch from the *vertebræ*, and intending to take it up whole, begun to cut at what we thought a proper distance; but found we cut thro' a bone; and with the *vertebræ* brought up three or four inches of the *os femoris*, with the ball, covered with the *periosteum*: but the animal has been so crushed hereabouts, that we could make little of the socket or *os innominata*. Several of the ribs came up with the *vertebræ*: they were broke, and laid parallel to the *vertebræ*; but not quite close, there being some of the rock between them. The *periosteum* is visible on many of the bones.

*G, H*, Twelve *vertebræ* remaining in the rock, with which they are almost covered, especially towards the extremity.

The

The place, where these bones lay, was frequently covered with sea-sand, to the depth of two feet, and seldom quite bare; which was the occasion of their being rarely seen: but being informed that they had been discovered by some people two or three years ago, we had one of them with us upon the spot, who told us, that when he first saw it, it was intire, and had two short legs on that part of the *vertebræ* wanting towards the head. Altho' we could not suspect the veracity of this person, we thought he was mistaken; for we had hitherto taken it for a fish. But when we took it up, and found the *os femoris* above-mentioned, we had cause to believe his relation true, and to rank this animal amongst those of the lizard kind: by the length (something more than ten feet) it seems to have been an allegator; but I shall be glad to have thy opinion about it.

I am thy friend,

William Chapman *Sen.*

*The bones were sent up, and are herewith presented  
to the Royal Society by*

J. Fothergill.

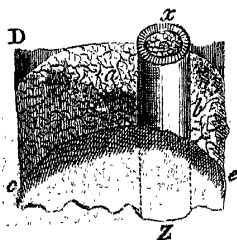
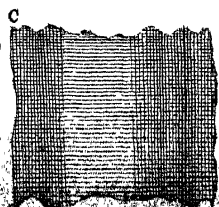
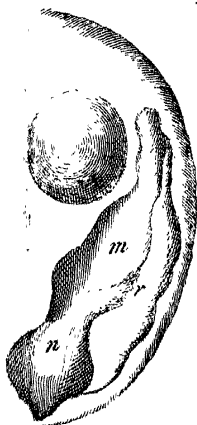
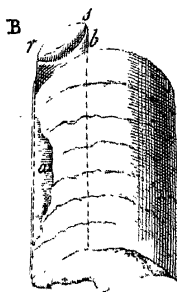
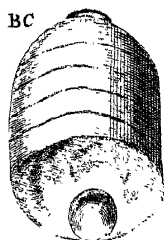
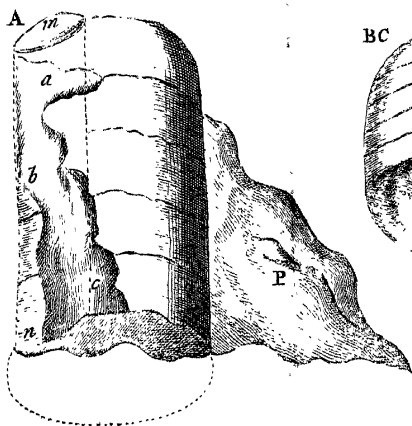
**XCIII.** *De rariori quadam Orthoceratitidis Specie, in Suecia reperta, tractatus: in literis a Nicholao de Himfel, M. D. Riga Livono, ad Gul. Watfon, M. D. R. S. S.*

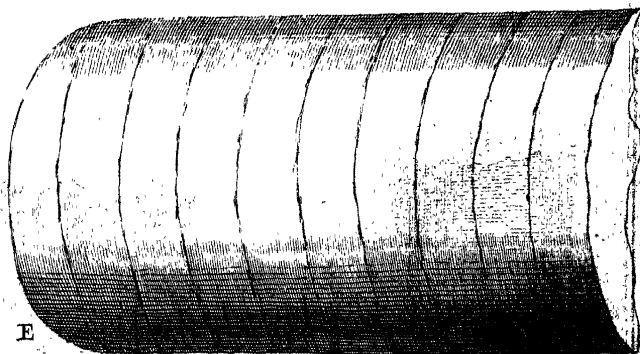
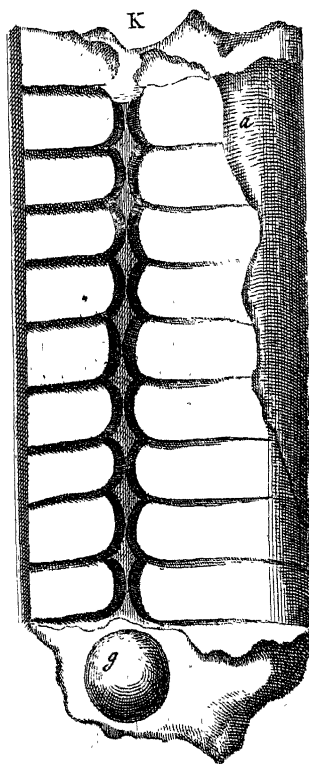
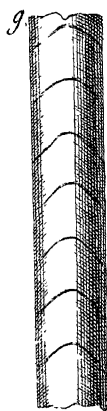
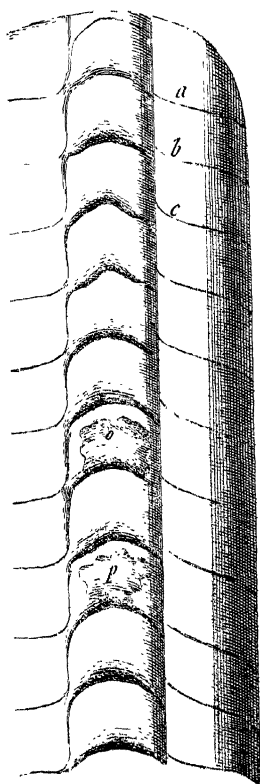
Read May 11,  
1758. **O** Orthoceratiti recti in loco quodam Kelwika dicto, prope Fahlunam in Dahlia, reperti. Inhærebant lapidi cineracei coloris calcareo, variæ magnitudinis orthoceratiti, quorum portiones hic delineatas describo.

*Vide T A B. XXIII.*

*Fig. A.* Orthoceratitis portio, cujus pars inferior saxo adhuc adhæret; ex lapide calcareo constans lente in apicem decrefcens. Licet ex parvis ejus fragmentis judicari possit, cylindrum esse orthoceratitem, ea tamen si conjunguntur, verum formant conum, et mihi videtur ex crassitie siphonis, orthoceratitem hunc conicum duos fere superavisse pedes. Vidi orthoceratitem in alio lapide calcareo, quem etiam ibidem loci, Kelwikæ, reperi, longitudine duorum cum semisse pedum: sed impossibile erat, integrum eum excutere, nimis enim fragile erat. Est portio hæc orthoceratitis testa sua ambiente vestita in *abc*. Quinque conspiciuntur articuli, thalami quondam, arctissime sibi invicem insidentes, per quos a latere procedit siphon *m n* sat crassus, qui in omnibus fere, quas possideo portionibus orthoceratitarum,









rum, a centro semper remotus, hic ad peripheriam positus conspicitur. Siphon admodum lente decrefcit, ex quo etiam de longitudine coni hujus judicare licet. Cruftæ vel testæ *a b c* interior pars, quæ articulos tegit, cryftallina eft, ex fpati cryftallis tenuioribus irregularibus confans.

*Fig. B.* Portio alia, in qua articuli minus craffi; fiphon quoque ad peripheriam positus, testa fua in *a* tecta. Confpicitur feptum illud testaceum in *b*, communi tenuior, quod ab ipfo articulo superiori procedens, fiphonis partem *r s* investit.

*Fig. B, C.* Portio orthoceratitis ex lapide calcareo cineracei coloris: fiphon vero, fluore fpatoso egregie cryftallifato, confat.

*Fig. C.* Portio alia per axin divifa, cujus pars exterior, testa quæ ftriis circularibus levioribus externe ornata, investita confpicitur.

Ex parte interiori *Fig. D.* confirmatio ejus interna adparet. Siphon  $\propto\propto$  gracilior, inter centrum et peripheriam positus, dimidia parte ambiente articulo denudatus adparet; dimidia altera, inferiori articulo *c d e* tegitur. Articulus *a b* fpatio cryftallifato pellucido polygono repletus eft. Articulus *c d e* vero, faxo fpatoso incarnato paululum repletus eft.  $\propto$ . Siphonis pars superior, ubi radii a peripheria ad centrum tendentes confpiciuntur. Inter cryftallos fpatofos in articulo *a b* ftriæ hinc et inde adparent nigræ, afphalto repletæ; ita etiam cavitas articuli *a b*, æque ac superficies convexa articuli *c e*, quæ in primam concavam recipitur, lamina afphalti vestitæ funt.



*Fig. E.* Pars alia orthoceratitis majoris, et quidem facies exterior.

*Fig. F.* Facies ejus interior, in medio divisi, cum siphone transeunte satis crasso. *abc* et reliquæ striæ leves, sunt diaphragmata, articulos *ab* invicem separantia, siphonem proprie constituentia, siphonisque tenuiorem membranam, quæ in *o* et *p* adhuc conspicitur, ambientia. Sunt diaphragmata hæc crassiora in siphonis vestigiis, et sibi invicem ab inferiori parte insident. Siphon hic inter centrum et peripheriam positus est.

*Fig. G.* Materies calcarea, quæ siphonem replevit striata, et quidem pars ejus interior, qua centrum orthoceratitis respicit, peripheriæ opposita.

*Fig. H.* Facies posterior, peripheriæ propior.

*Fig. I.* Pars concava articuli majoris orthoceratitis, in qua diaphragmatis testacei jam crystallifati portiunculæ albicantes *mnr* conspiciuntur cum siphone transeunte.

*Fig. K.* Portio alia orthoceratitis majoris, ejusque facies exterior, cum siphone *g* ad peripheriam posito. Conspiciuntur hic diaphragmata, quæ ab utroque latere, ab articulis procedunt, se invicem conjungunt, et siphonem ab exteriori parte obtegunt. *a* est testæ satis crassæ portiuncula, qua portio hæc orthoceratitis vestita adhuc est.

XCIV. *A further Account of the Effects of Electricity in the Cure of some Diseases* \*: *In a Letter from Mr. Patrick Brydone to Dr. Robert Waytt, Professor of Medicine in the University of Edinburgh, and F.R.S.*

Coldinghame, January 9th, 1758.

Read May 11.  
1758.

**A** Young woman of Aiton, a village about two miles from this place, had her right leg drawn back by a contraction of the muscles that bend the knee, so that she had not been able to put that foot to the ground for near a twelvemonth. She had taken the advice of some Surgeons in the country, and had used several remedies to no purpose. At last, hearing of the cure of the paralytic woman, whose case I sent you some time ago, she insisted on being brought hither; and underwent a course of electrical shocks for near two months, receiving every day at least fifty or sixty in the following manner. She sat close by the machine, and grasping the phial in her hand, she presented the wire to the barrel or conductor, and drew the sparks from it for about half a minute. The phial being thus charged, she then touched her knee with the wire, and thereby received such severe strokes, as would sometimes instantly raise a blister on the part. The joint was at last so much relaxed, as that she could walk home with the help of a crutch, tho' her leg was so weak, that she had very little use of it. After

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\* For the first account, see part first, p. 392.

she had continued in this state for some weeks, she was advised to use the cold bath: but that soon brought back the contraction; and I have been since informed that she was worse than ever.

A soldier's wife, a genteel looking woman, of about 30 years of age, was seized with a slight palsy, about Newcastle, on her way to this country: but before she got to this place, she had lost all the feeling in her left side, and so far the power of it, that she was brought to us in a cart. After receiving 600 strokes from the electrical machine in the usual way, and in the space of two days, she recovered the use of her side, and set out on foot to make out the rest of her journey. However, for fear of a relapse, I gave her a recommendatory letter to Mr. Sommer, Surgeon at Haddington, as she was to pass thro' that town, and as I knew that he was likewise provided with an electrical apparatus.

A young woman from *Home*, a village in this shire, but at a good distance, complained of a coldness and insensibility in her left hand and wrist, of two years standing. When I felt that hand, it was as cold as a stone, whilst the other was sweating; and she told me, that it never had been warmer all that time. I made her draw the sparks from an egg (which for some other purpose was suspended by a wire from the conductor) for about half an hour; and at the end of that time I found the dead hand in a far greater sweat than the other. She then wrapt it up in a piece of flannel, as she used to do, and retired. Next day she told me, that since the operation she had been able to put off and on her cloaths without help,

help, which she had not been able to do for a twelvemonth before. She was again electrified ; and believing she was then quite well, she went away : but some weeks after, upon the coldness of her hand beginning to return, she made me another visit, was again electrified, and was dismissed a second time apparently cured. This is about two months ago, and I have heard nothing of her since.

As these two last women are at such a distance, I cannot pretend to send you their own testimony of their cure. But for the two cases in the separate paper, as the persons are inhabitants of this place, I have taken care that they themselves should sign them, along with my father ; since you have acquainted me, that accounts of this kind should have the attestation both of the patients and the minister of the parish.

I shall only add here, that several persons have been relieved of rheumatic pains, by electrifying the parts affected. And a woman was cured of a deafness of six months standing, contracted, as she imagined, by cold. This woman held the phial in her hand, whilst another person standing on a cake of resin gave her the shock, by putting the end of the wire into her ear. This manner of electrifying brought always on a profuse sweat over the head, which we encouraged, by wrapping it up in flannel. The first day she came here, she could scarce hear what was spoken by those about her ; but in five days she seemed to be perfectly cured.

I am, &c.

Patrick Brydone.

*Copy of the separate Paper before mentioned.*

Robert Haigs, of Coldinghame, a labouring man of about 45, after having been for ten days ill of a regular tertian ague, at my desire underwent the electrical shocks in the common way. After having received about thirty or forty very severe ones, he grew pale, and staggering for several steps, would have fallen down, had he not been supported. He then fell into a sweat, which continued near half an hour. I desired him to come back the next morning, immediately before the fit, which he said came on about ten o'clock. He accordingly came, and told me he had not the usual symptoms preceding the fit. He was that day again strongly electrified; and has been without any aguish symptom ever since; *viz.* for the space of four months.

The truth of this is attested by

ROBERT HAIGS, *the person cured:*

ROB<sup>T</sup>. BRYDONE, *Minister of Coldinghame.*

Ann Torry, of Coldinghame, a young woman of about 20, had a regular tertian (being the first time she ever had the ague) for near a fortnight. The fit came on early in the morning. She was electrified on her well day in the afternoon; and the next morning, having had only a slight shivering, she

was

was electrified again about ten o'clock, and has had no symptom of the ague since; viz. for three months.

The above is attested by

ANN TORRY, *the person cured.*

ROBT. BRYDONE, *Minister of  
Coldinghame.*

XCV. *An Account of the Black Affize at Oxford, from the Register of Merton College in that University. Communicated by John Ward, LL. D. With some additional Remarks.*

*Anno nono D. Bickley Custodis, 1577.*

Read May 25, 1758. **V**iceffimo (1) primo Julii in vestiario Dñus custos et octo Seniores dispenfarunt cum *Decreto de concione et appiētantia habendis, die Dominico post festum S<sup>i</sup> Petri ad vincula*; ne vocata et conveniente turba, morbus ille, qui ante quinque dies quamplurimos infestarat, dissipator et periculosior fiat. Etenim 15, 16, et 17, hujus Julii aegrotant plus minus trecenti homines; et infra duodecim dierum spatium mortui sunt (ne quid errem) centum scholares, praeter cives non paucos. Tempus sine dubio calamitosissimum et luctu plenum.

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(1) Sic in regist. et postea haud semel.

Nam quidam lectos differentes (2), agitati nescio quo morbi et doloris furore, suos custodes baculis caedunt et abigunt; alii per areas et plateas insanientium more circumcursant; alii in profundam aquarum praecipites infiliunt; nemo tamen, summo Deo gratia, desperanter perit. Franguntur omnium animi. Fugiant medici, non propter necessitatem fratrum, sed propter se et cistas creati. Relinquuntur miseri. Domini, doctores, et collegiorum praefecti, ad unum pene omnes abeunt. Custos noster, longe omnium vigilantissimus, domi apud nos manet; in aegrotis omnem curam, laborem, diligentiam impensus (3) collocat; die toto, et nocte etiam intempesta, eos sedulo invisit. Moriuntur e nostris quinque. Omnis aula, omne collegium, aut domi, aut in via ad patriam, suos habet mortuos. Mirari quis posset multitudinem ad medicastrosum domos cum matulis citato cursu properantium. Pharmacopolarum etiam conservata syrupos, olea, aquas dulces, pixides, cujusque generis confectiones, brevissimo tempore exhausta. Laborant aegroti vehementissimo tum capitis tum stomachi dolore; vexantur phrenesi; privantur intellectu, memoria, visu, auditu, et caeteris etiam sensibus. Crescente morbo, non capiunt cibos, non dormiunt, ministros aut custodes non patiuntur. Semper, vel in ipsa morte, mirae orum strenuitas et corporis robur; et eo declinante, omnia modis impense contrariis eveniunt. Nulli complexionis aut constitutionis parciunt; cholericos tamen praecipue hic morbus molestos habet; cujus ut causas, sic et curas ignorant medici. Natum suspicantur multi, vel ex

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(2) Sic in regist.

(3) Sic in regist.

foetido et pestilenti furum e carceribus prodeuntium aëre (quorum duo vel tres sunt ante paucos dies in vinculis mortui) vel ex artificiosis diabolicis et plane papisticis flatibus e Lovaniensi barathro excitatis, et ad nos scelestissime et clam emissis. Nam illi solum et hic et alibi decumbunt aegroti, qui in castro, et *guilda*, quam appellant, aula, quinto et sexto hujus mensis adfunt (4). Affisiorum judices, dominus Robertus Bell, capitatis baro scaccarii etc. qualem hactenus non peperit Anglia; dominus Johannes Barrham, dominae reginae serviens ad legem; papisticae pravitatis uterque apertissimi hostes et acerrimi vindices: vicecomes Oxoniensis comitatus (5), equites aurati duo, armigeri et pacis justiciarii octo, generosi plures, horum non pauci famuli, omnes (uno aut altero exceptis) *de grandi*, ut loquuntur, *jure*, statim post fere relictam Oxoniam mortui sunt. Et ut quisque fortissimus, ita citissime moritur. Foeminae non petuntur, nec certe pauperes; neque etiam inficitur quisquam, qui aegrotorum necessitatibus subministrarit, aut eos inviserit. Sed ut fuit morbus hic insigniter violentus, ita neque diu duravit. Nam infra unius mensis curriculum ad pristinam pene sanitatem restituuntur omnes; ut jam denuo mirari possis tot scholares, tot etiam cives, urbem et plateas linteis capitibus obambulant, et nomen clementissimi Dei nostri in omne aevum suspicere (6).

Vicesimo quarto Julii Joannes May, socius et artium magister, in collegio vitam finit. Sepelitur in ecclesia.

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(4) Sic in regist.

(5) Sic in regist.

(6) Sic in regist.



Viceffimo feptimo ejufdem Browne clericus moritur in collegio.

Viceffimo octavo ejufdem Gaunte portionifta moritur in collegio.

Viceffimo nono Dnus Lea, electus probationarius 20 Julii, moritur in collegio.

*Additional Remarks, by Tho. Birch, D. D.  
Secret. R. S.*

CAMden, in his Annals of Queen Elizabeth (1), observes, that almost all, except women and children, who were present at the affizes at Oxford, at the tryal of Rowland Jenkes, a Bookfeller there, for feditious words, died, to the number of about three hundred. Mr. John Stow, in his *Chronicle of England* (2), enlarges this number, and affirms, that there died in Oxford three hundred persons, and in other places two hundred and odd, from the 6th of July to the 12th of August; *after which died not any of that sickness; for one of them infected not another*: And this historian agrees with Camden, that not any one woman or child died thereof. Dr. George Ethryg, a phyfician, who practifed at that time at Oxford (3), in the 2d book of his *Hypomnemata quædam in aliquot Libros Pauli Æginetæ, seu*

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(1) Page 285. edit. Lugd. Batav. 1625.

(2) Page 681. edit. London, 1631.

(3) Wood Hift. et Antiqu. Univerfit. Oxon. lib. i. p. 295. and Athen. Oxon. vol. I. col. 237.

*Observationis Medicamentorum, quæ hac ætate in usis sunt*, printed at London in 1588, in 8vo, mentions, that on the first night of the appearance of the disease about six hundred fell sick of it; and that the next night an hundred more were seized in the villages near Oxford. Lord Bacon, in his *Natural History*, evidently refers to this, and one or two more instances of the same kind, in the following passage, *Century X. N<sup>o</sup>. 914.* “ The most pernicious infection next “ the plague is the smell of the goal, where prisoners “ have been long and close and nastily kept; where- “ of we have had in our time experience twice or “ thrice, when both the judges, that sat upon the “ goal, and numbers of those, that attended the “ business, or were present, sickened upon it, and “ died. Therefore it were good wisdom, that in “ such cases the goal were aired before they be “ brought forth.” We have likewise an account in Mr. Anthony Wood (4), that at the quarter-session at Cambridge, in Lent in the year 1522, and the 13th of the reign of Henry VIII. the justices, gentlemen, and bailiffs, with most of the persons present, were seized with a disease, which proved mortal to a considerable number of them; those, who escaped, having been very dangerously sick. With regard to the unhappy instance of the same kind of contagion, which happened at the session in the Old Baily in May 1750, see Dr. Pringle’s excellent work, intitled, *Observations on the Diseases of the Army in Camp and in Garrison* (5).

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(4) Hist. & Antiquit. Univerfit. Oxon. ubi supra.

(5) Page 290, 2d edit.

XCVI. *A Description of the Plan of Peking, the Capital of China ; sent to the Royal Society by Father Gaubil, è Societate Jesu. Translated from the French.*

KING CHE. THE COURT.

Read June 1. 1758. **I**N this plan are the inclosures of walls, which form as it were three cities.

The first is the imperial palace, or imperial city. It is called *Kong tching* or *Tse kin*. The numbers 11, 17, 21, 24, mark the great gates of this inclosure. Kong tching,  
Tse kin.

The second inclosure is *Hoang tching*. The numbers 3, 18, 30, 86, mark four great gates of this inclosure. Hoang tching.

The third inclosure is *King tching*, or Royal City. The numbers 235, 1, 99, 146, 173, 183, 188, 199, 211, mark nine gates of this inclosure. King tching.

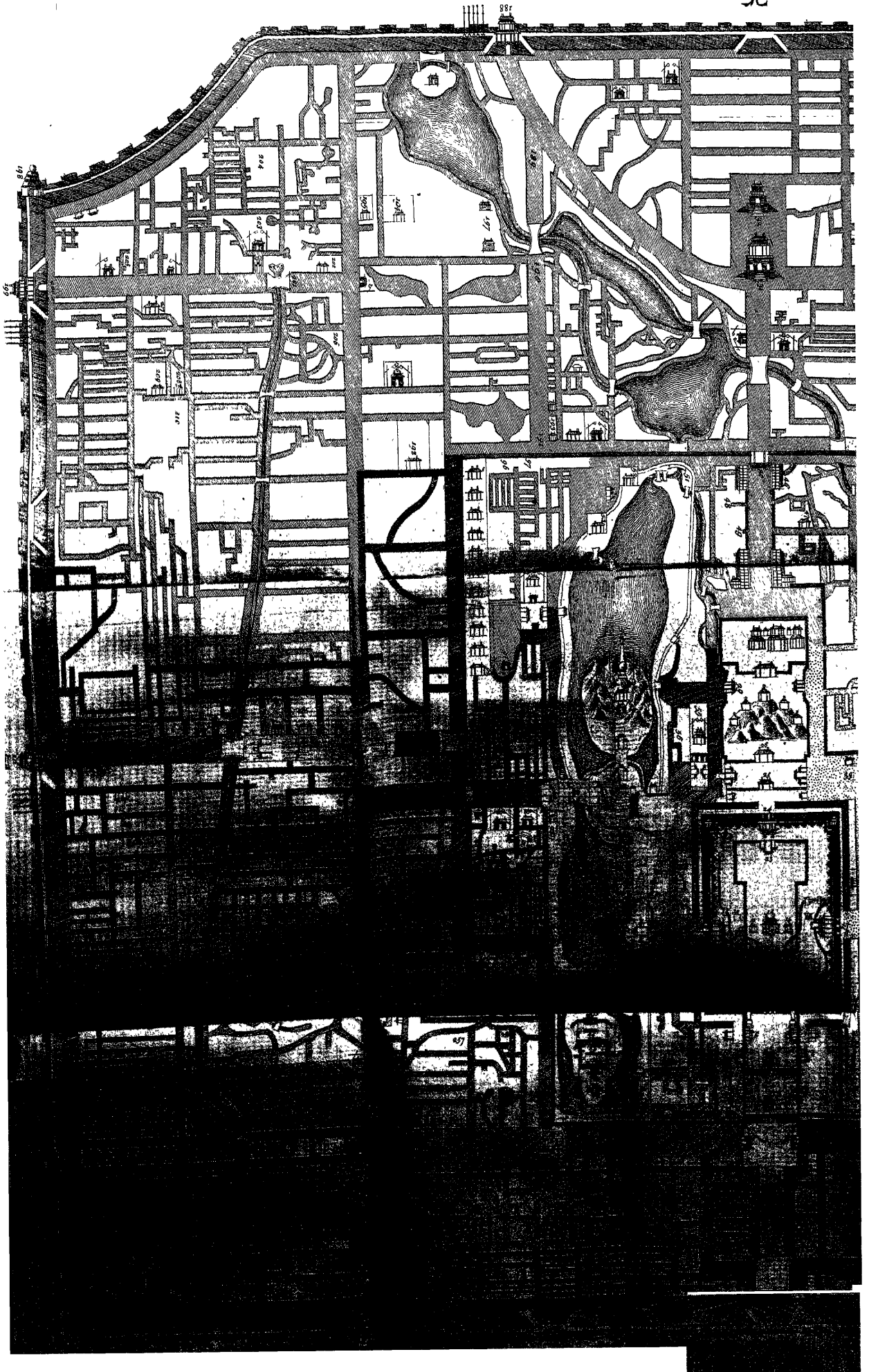
At the four angles east and west of the north and south walls is a large pavillion in the form of a fortress. It is a kind of arsenal or magazine of arrows, bows, guns, bucklers, cuirasses, pikes, small cannon, &c.

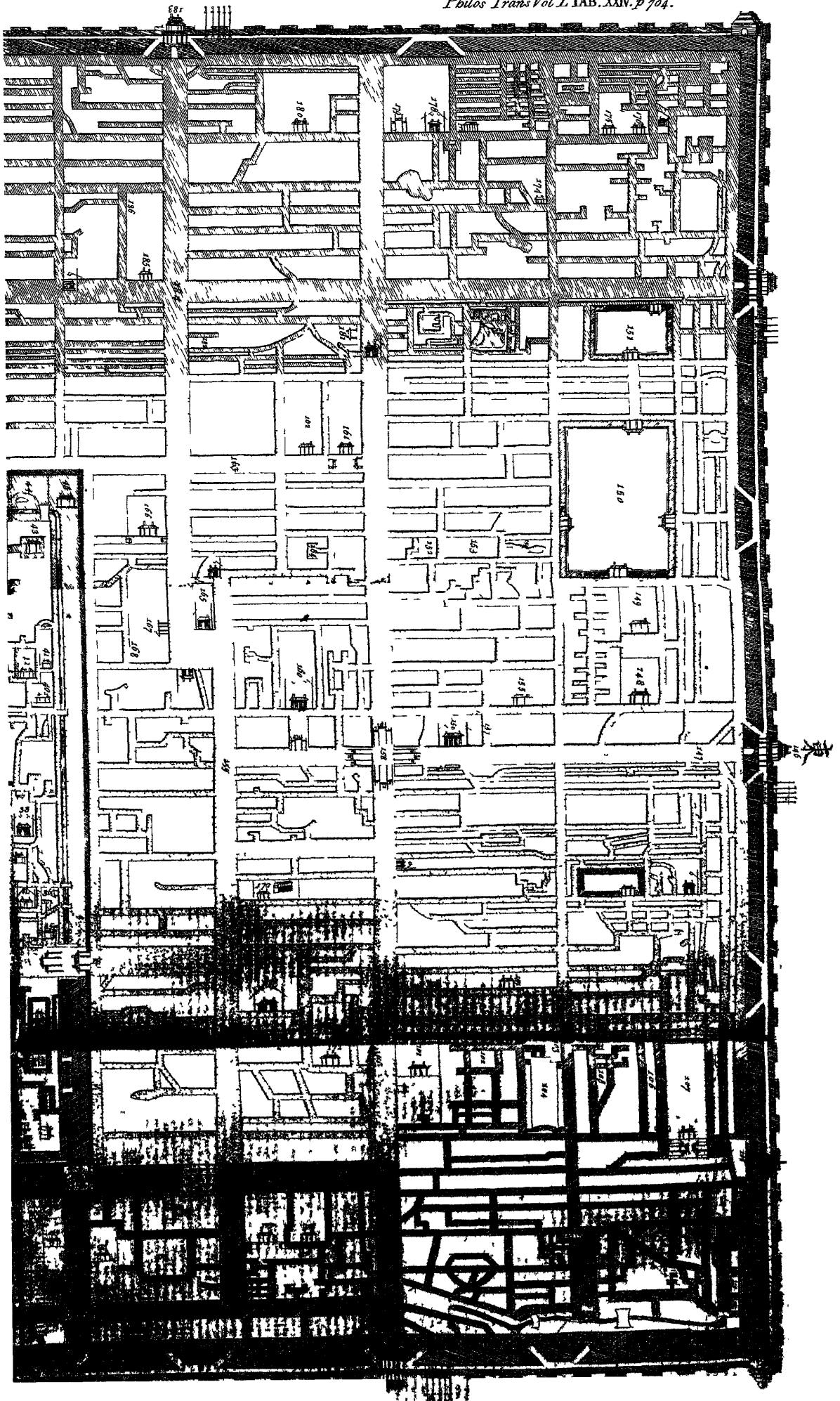
Observe the angle made by the inclosure *Hoang tching* on the south of the gate N°. 84, to the north  
of



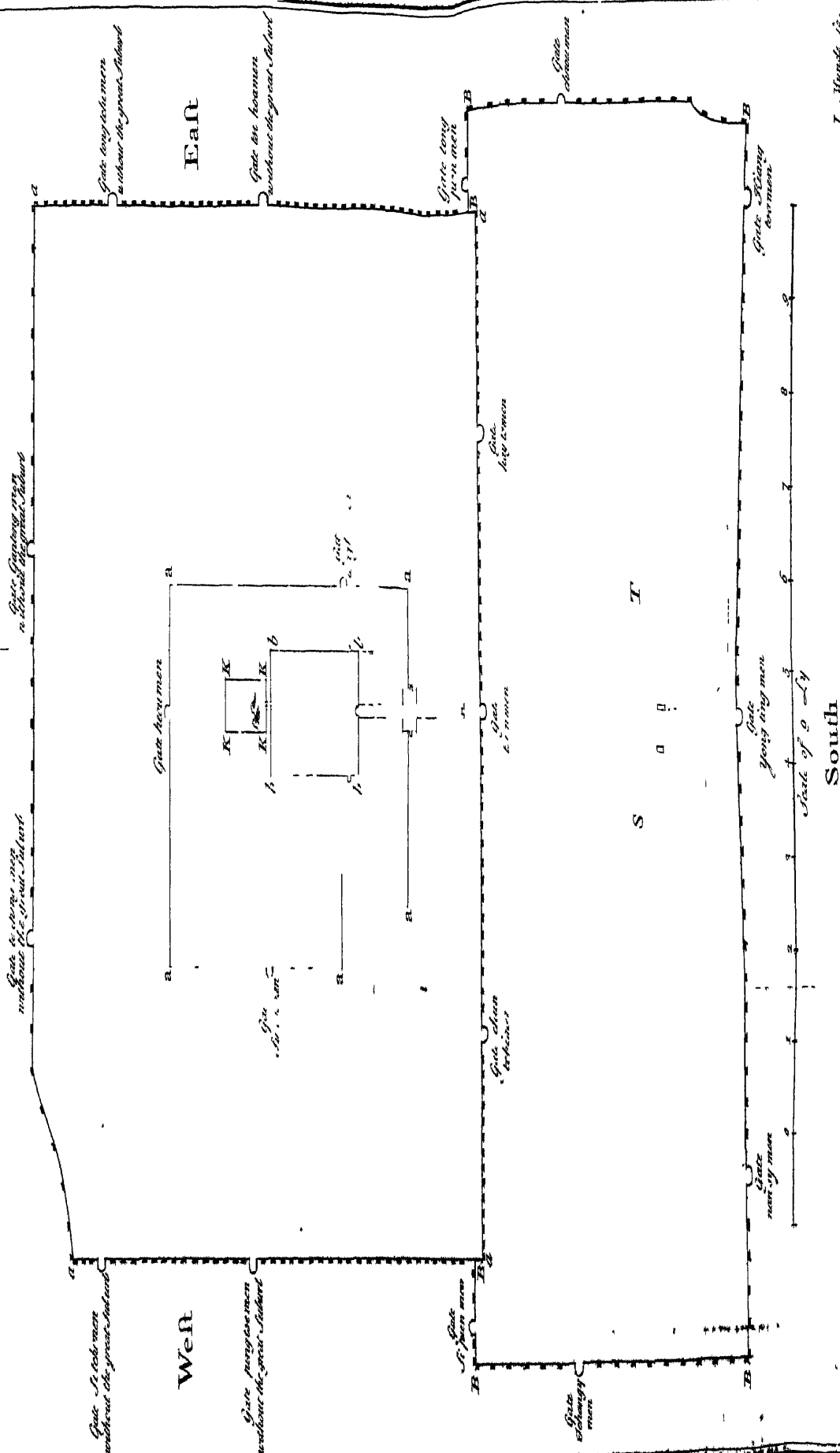


北





aaaa King Iching. aaaaa Hoang Iching. bbb b Tuckin. BBBBBB ouuy Iching  
The Southern or outward City.  
T. Tienan. S. Sen nuying ting. North KKKK c. King chan.







of N°. 260. The inclosure extends to the east, then to the south, and continues to the east, passing by N°. 3.

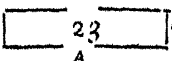
1. is the great gate *Hien men*. As you go on to the north, 2, 143, 214, are three gates of a great court with magnificent walls. Thro' the gate 3 you enter into a court, where is the *Tay miao* N°. 7. There are repositied the tablets of the ancestors of the reigning emperor, and of the illustrious subjects deceased, who have served the dynasty. This *miao* or palace is a vast one, and well kept. At regular times the emperor, princes, and great men, go thither to perform ceremonies.

N°. 9 is the *Che tsi tan*, where are performed, at regular times, the ceremonies to the ancients, who have taught the art of agriculture. This palace is a very beautiful one. 4, 5, 6, are the gates of a court, where the *reguli* and princes go frequently to receive the emperor's orders. There are halls for their reception. The mandarins give them tea to drink, and mark their names in a register. When upon the fixed days they cannot attend, they are required to give notice of it. It is in this court, that the tributary princes, or their envoys, do homage, and receive the presents of the emperor; which presents are considered as rewards.

N°. 11 is *Ou men*, the great gate with a beautiful pavillion of a considerable height, in which is a large bell \*. This gate, with those marked N°. 12, 13, are those of the great court; whence going to the

\* When the emperor goes out or comes into the palace, this bell is rung.

north, you enter into the beautiful and vast court *Tay ho tien*, the gates and galleries of which, with the balconies, make a fine appearance. In this court, on the first day of the year, and on other fixed days, the mandarins, according to their ranks, perform the ceremony to the emperor, who is seated on his throne in the hall called *Tay ho tien*. This hall is a vast and magnificent one. The princes, ministers, and great men of the first order, place themselves there by the emperor. It is in this hall, that the emperor gives audience to foreign princes and their ambassadors. You go up to this hall by magnificent steps.

To the north of *Tay ho tien* is a large court, whither the princes, great men, ministers, and principal mandarins, go in turns every day, to receive the emperor's orders, or to present their petitions. To the north of this court are the apartments of the emperor, the empress, the queens, and ladies. The great gate of the place, where these apartments are, is N<sup>o</sup>. 23. All these apartments are in the space contained within the walls, which have this figure .

At A is a beautiful gate to the south. The walls of the inclosure of the apartments of the emperor and empress are higher than those of the inclosures of the queens and ladies. In them are orchards, jets d'eau, flowering shrubs, and a great number of small chambers for the eunuchs.

To the west of the court *Tay ho tien* is the fine palace *Tsi ning kong*. The empress-mother lives there at present. Every thing in this palace is beautiful. There are little gardens very neat and well kept.

kept. At the east of the *Tay ho tien* is likewise a fine palace, where the prince heir, with his court, resided in the time of the emperor *Kanghi*. It is a very beautiful palace, and highly ornamented.

In the inclosure of *Kong tcbing*, or *Tse kin*, there are tribunals, a great number of magazines, manufactures, the imperial apothecary's shop and printing-house; schools for the Chinese and Tartar languages; and several temples of idols, one of which, lately made for the lamas, cost immense sums.

N°. 26, 28, 29, are the gates of the great inclosure called *Kin chan*. It is properly a beautiful pleasure-house, which the present emperor has caused to be extremely embellished. There are in it fine gardens with walks of trees, very rich and elegant apartments, halls for the musicians and comedians. From the mountain *m*, the last emperor of the dynasty *Ming*, seeing the city taken by the rebels, hanged himself on the morning of the 15th of April of the year of our Lord 1644. On the day before, the 14th of April, the empress hanged herself in the evening in the palace. The mountain in *Kin chan* was made by art a long time ago.

At the west of the inclosure *Kin chan* and *Tse kin* observe the great laos. 54 is the *peta*, or white pyramid. This pyramid stands on a small mountain, which makes an island. The present emperor has built there, in the form of an amphitheatre, I do not know how many apartments with covered and open galleries, well built, and in a good taste: the point of view is charming, and the galleries, which run over the lake, are extremely beautiful. There are two or three temples of idols. 53 is a fine

building with a temple of idols; and in it a statue of *Fo* of an extraordinary height. It is of copper, gilt, and cost great sums. 76 is a very beautiful palace called *Ng tay*, with fine gardens, fine halls, and fine walks.

55 is the palace, in which is placed the tablet of the emperor *Kang hi*, grandfather to the present emperor, who at regular times goes thither, in order to honour the memory of that great prince, one of the most illustrious and fortunate sovereigns of the empire of China.

81 is the house and church of the French Jesuits. The house stands in  $39^{\circ} 55'$  of northern latitude, or possibly some seconds more, and  $114^{\circ}$  to the east of the observatory of Paris. This situation, with regard to latitude and longitude, is founded upon a considerable number of astronomical observations. By means of a scale, which may be made, we have the distance between this house and the other parts of the city, north and south, east and west; as likewise the latitude and longitude of all the places in the city of Peking. 248 is the house and church of the Portuguese Jesuits; 170 the house and church of the Portuguese Jesuits\*; 131 the house and church of the Russians. A little to the east of N°. 176 is a small house and chapel for the Russians settled at Peking for above seventy years past.

31 is *Kou leou* †, the Tower of the Drum; 32 is

\* In these two houses are Jesuits of other nations. They are styled Portuguese, because these houses and churches depend on the mission of the Jesuits founded by the king of Portugal.

† There are beaten there the five watches of the night. The sound is heard thro' the whole city.

*Tchong leou*, the Tower of the Bell; in which is a very large bell ‡.

179 was formerly the palace of the fourth son of the emperor *Kang hi* after the death of *Kang hi*. This prince reigned under the name of *Yong tching*. His son the present emperor caused this palace to be demolished, and to be rebuilt with an extraordinary magnificence. In the hall is the tablet of *Yong tching*; and there are in this palace grand apartments for the emperor, when he goes thither to honour the memory of his father. The emperor has erected here a temple of idols for the lama of Thibet; and there are apartments for above three hundred lama's. These have Chinese and Tartar disciples to the number of two hundred. Here are taught, in the Thibetan language, called here *Tan gout*, the sciences, arts, mathematics, physic, spirituality, and the pagan religion. In this beautiful inclosure there are statuary and painters. This building is not at all inferior in beauty and magnificence to those of the palace of Peking, or to those, which the present emperor is going on to erect in his pleasure-houses.

180 *Koue he kien* is the imperial college. The great hall, where Confucius is honoured, is a very beautiful one. There are likewise halls for honouring the disciples of this philosopher and several eminent Chinese learned men, who have followed his doctrine with success. The emperor goes thither sometimes to perform the ceremony to Confucius as master and instructor to the empire. The avenues,

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‡ *Yong lo*, emperor of the last dynasty *Ming*, built these two towers.

courts, and apartments, of *Koue he kien* have a most majestic appearance.

70 the smaller observatory.

108 the imperial observatory, built by *Kia ling*, emperor of the last dynasty *Ming*.

136 the tribunal of mathematics, *Kin tien kien*.

137 the tribunal of mandarins, *Ly pou*.

139 the tribunal of rites and ceremonies \*, *Ly pou*.

133 *Ping pou*, the tribunal of war.

134 *Kong pou*, the tribunal for public works.

140 *Heu pou*, the tribunal for the finances.

142 the tribunal of princes, *Tsong gin fou*.

168 *Hing pou*, the tribunal for criminal causes.

144 *Li fan yuen*, the tribunal for foreign nations, Thibetans, Eleuthians, Russians, and indeed for all foreigners, who come by the way of Tartary from the west

369 *Tou tcha yuen*, the tribunal of the censors of the empire. It has under it the *provosts* and *mare-chauffée*.

233 the tribunal of *Kieou men ti tou*, or governor of the nine gates, that is, the governor of the city.

185 the tribunal of the judge of the city. This judge is here called *Fou yn*. He has under him two judges named *Tchi hyen*. One of these is the judge of the district called *Ouang ping kien* 193. The other is called the district of *Tay tsing kien* 182. These districts are within the city and without it. What is called at Peking *tou yn* is called elsewhere *tchi fou*.

\* The tribunals of the ministers and grand masters of the emperor's house are in the inclosure *Tse kin*.

128 is the tribunal of *Han lin*, or the chosen doctors of the empire. This tribunal, called *Han lin yuen*, is a very considerable one: it has the care of the registers for the Chinese history. All the learned men of the empire, and the colleges and schools, depend upon this tribunal. Here are chosen the judges and examiners of the compositions for the degrees of the learned men; as likewise those, who are most capable of writing verses and pieces of eloquence for the use of the palace and emperor.

107 *Kong yuen* is the inclosure, where the compositions are drawn up for the examination of the learned men. Here are a great number of little chambers or cells for the composers, and fine apartments for the mandarins appointed to preserve good order, and to prevent those, who compose, from making use of the compositions of others.

273 *Tchoua kou ting* is a pavillion, in which is a drum. Mandarins and soldiers keep guard here day and night. In ancient times, when any person had not justice done him, and thought himself oppressed, he went and beat this drum; at the sound of which the mandarins ran, and were obliged to carry the complaint of the party oppressed to the great men or ministers. Upon which information was taken of the fact, and justice done. At present the use of this drum is abolished; but it has been thought proper to preserve this ancient monument of the Chinese government.

217 *Ti ouang miao* is a palace, wherein are the tablets of a great number of the ancient emperors of China. At the time of the equinoxes the emperor goes thither to perform the ceremonies to these de-



ceased emperors. See the notes on the *Ti ouang miao*, p. 723.

92, and the continuation of the buildings to the north, contain the magazines of gunpowder, salt-petre, and nitre. In the city are many other magazines. I do not name them here. They have their numbers. These magazines are of cloth, mats, skins, oil, wine, vinegar, wood, coal, porcelain, tea, varnish, silk, &c.

The city is divided into eight quarters for the bannieres of the Tartars *Mantcheou*, the Tartars *Mongou*, and the Chinese called *Han kun*, who follow the Tartars *Mantcheou*, and submitted to them when they entered China. Since that time the Chinese *Han kun* are become numerous and powerful. These eight banneries are divided by this means as it were into twenty-four; viz. eight of *Mantcheou*, eight of *Mongou*, and eight of *Han kun*. Each bannery has its officers, magazines, and arsenal. These are pretty spacious inclosures, each of which has its number.

94 is an inclosure, in which are kept tygers; and 240 an inclosure, wherein are elephants.

65 *Tsan yuen* is an inclosure for silk-worms.

147, 150, 151, are public granaries, very well built. Without the gates 146, 173, are many of these public granaries; as also in the environs of the city to the north, south, east, and west. The largest and most magnificent are in the city of *Tong tcheou*, four French Leagues to the east of Peking.

37, 38, 42, 52, 54, 59, 60, 66, 80, 83, 84, 85, 91, 93, 117, 118, 152, 154, 156, 160, 165, 178, 196, 203, 210, 215, 218, 225, 229, 230, 250, 255, 261,

261, these numbers mark temples of idols. Some of these numbers mark halls for honouring of illustrious deceased persons; but of these there are only a few. There are several small *miao*, which are not numbered. In the Chinese city, in the suburbs, are many temples of idols; and some even in the emperor's palace. And almost all the palaces of the princes have idol temples.

33, 35, 36, 61, 62, 64, 67, 68, 71, 109, 126, 128, 133, 134, 135, 136, 137, 139, 140, 141, 142, 144, 180, 182, 185, 193, 219, 222, 233, 243, 251, 252, 253, 254, 255, 259, 260, 267, 268, 269, 270, 271, 297, these numbers mark the tribunals, as well those, which I have already mentioned, as many other subaltern ones, which depend on them. There is one for the physicians.

101, 119, 121, 124, 125, 129, 148, 149, 155, 161, 162, 166, 172, 174, 175, 176, 192, 194, 195, 202, 208, 209, 216, 220, 221, 224, 232, 237, 238, 239, 241, 244, 247, 249, 262, 263, 264, mark the palaces of the princes of the blood, who are divided into several classes *Tsing ouang*, *reguli* of the first order; *Kun ouang*, *reguli* of the second order; *Pey le*, *reguli* of the third order; *Pey tse*, *reguli* of the fourth order; *Kong*, or counts, divided still farther into other classes; and *Tsiang kun*, or generals of armies, divided likewise into other classes.

Some years ago the emperor caused to be measured the circumference of the walls of *King tching*, of *Hoang tching*, and of *He kin*, &c. as likewise the breadth of the streets, the space filled by the *miao*, our three churches, that of the Russians, palaces, &c. The Chinese city was not measured. A draw-

ing of all this was made at large, and then reduced to a smaller scale, as it appears here. I will not undertake for the perfect exactness of it, either in the measures or the reduction. All this is by a Chinese hand. The foot made use of in this mensuration is to that of France as 1000 to 1016. 1800 of these feet make a *ly* \*. By the scale to be seen in the small plan, and from the dimensions of the south and east walls of *King tching*, may be deduced all the dimensions. The circumference of the walls of the Chinese city has been formerly measured, and well, by several measures; and the result of them may be seen here by the scale.

The south wall of *King tching* is from east to west eleven *ly* and near a third. The east wall from north to south is nine *ly* and some paces. So that the city is not square, as several persons have written.

The persons employed by the emperor to measure did not think of measuring the space, which contains the house and church of the congregation *de propagandâ fide*. This house and church are situated to the south between number 207 and a small bridge to the west of number 201.

In the accounts sufficient mention has been made of the walls and gates of the city of *King tching*; for which reason it is not necessary for me to say any thing concerning it.

In the year of our Lord 1267, the Tartar emperor *Koublay han* (in Chinese *Yuen chi t'sou*) built

\* The feet are different in China; but 1800 feet always make a *ly*. According to the measure of the foot the *ly* will be greater or less.

the city called *Ta tou*. It is the principal part of the present city of *King tching*. It contained the *Kin chun*, a palace *Yng tay*, *Hoang tching*, *Tse kin*, &c. the walls of the city, an observatory, the towers of the Drum and the Bell. *Yong lo*, emperor of the last dynasty *Tay ming*, made great alterations in the city built by *Yuen chi tjou*.

In the year 1406 the emperor *Yong lo* undertook to build stronger and higher walls, and more magnificent gates, to the city; to rebuild the *Hoang tching*, the emperor and empress's proper habitation, and the several parts of *Tse kin*, the courts, hall of the throne or of *Tay ho tien*, the *Kou leou*, the *Tchong leou*. He undertook also to build the *Sien nong tan* and *Tien tan*, which are now in the Chinese city. On account of the wars with the Tartars, the works undertaken by *Yong lo* were not finished till the year of our Lord 1421. Since that time, in the *Kin tchin* some alterations have been made in the palace, and a good number of new *miao* and palaces have been built. The emperor *Kia tsing* built the Chinese city in the year of Christ 1544.

The gates and walls of the Chinese city are not all equal in beauty to those in the city *King tching*. The streets are neither so broad, nor so well kept in repair. More than a third of the space of the Chinese city is not inhabited. It consists only of fields and gardens. The spaces occupied by the *Sien nong tan* and the *Tien tan* are vast; and between these two there is a very broad road. In this Chinese city are some mosques for the Mahometans. The inhabited part of this city is much more so than the city *King tching* and *Hoang tching*. In the Chinese city are vast inns for those, who come out of the southern

provinces to Peking. Here are likewise a curious manufacture of *lieou ly* or Chinese glass, rich merchants of women's ornaments, of gold, of the plant *gin cheng* so much esteemed and so dear here, of varnished furniture, tea, stuffs of value, &c. The booksellers shops are also in this city. It is to be remarked, that the walls of the Chinese city and *King tching* do not run directly north and south and east and west, but decline towards the north-west  $2^{\circ} 30'$ , and as much south-east. It is probable, that the architects employed in directing the building of these walls made use of a compass; and that the declination of the needle was then what is mentioned above.

What I have said of the walls of the city is likewise to be said of the walls of *Hoang tching* and of *Tse king*.

At the time of building the city *King tching*, and the Chinese city, the Chinese astronomers very well understood, that the north and south of the compass was not the north and south of the heavens at Peking; they knew, that the needle declined to the north-west and south-east; but that this declination was not considerable.

Without the gates of the Chinese city, and of *King tching*, I mark the suburbs; which are very full of people and merchants, and like so many cities. In most of these suburbs there are fine temples of idols.

The *Sien nong tan* in the Chinese city is almost fix *ly* in circuit. These three words signify, The hill of the ancient husbandmen.

The emperor goes thither every year in the spring  
to

to till the ground, and sacrifices on that hill to heaven. The emperor's apartments there have nothing magnificent in them; but the ceremony of ploughing is a solemn and curious one, and deserves a particular description. The emperor tills under a small covering of mat. When he has ploughed about half an hour, he ascends a large alcove, from whence he sees the princes, great men, and mandarins, plough in the fields, which are not covered with mats. While the emperor is ploughing, a good number of peasants sing ancient songs on the importance of ploughing. The emperor, princes, and great men, are dressed in the habit of plough-men, and their instruments of husbandry are very neat, and kept in a magazine. There are granaries for the grain produced by this tillage; and it is carefully remarked, that the grain from the emperor's tillage is much better than that from the labour of others. From this grain are made several cakes for the various sacrifices to Heaven or *Chang ti*. The emperor prepares himself for this ceremony by fasting, prayers to heaven, and a kind of retreat: and the intention of it is to keep up a memorial of those times, in which the princes themselves tilled the ground. This ceremony is of the highest antiquity in China.

Over against the *Sien nong tan* is the *Tien tan*, or Hill of Heaven, near ten *ly* in circuit. Every thing here is magnificent. The emperor goes thither every year at the winter solstice to sacrifice to heaven. He prepares himself three days for this ceremony by fasting, in a palace of *Tien tan*, called the *palace of fasting*. The hill, on which the emperor sacrifices, is magnificently adorned. At the four avenues are  
beautiful

beautiful triumphal arches of fine marble; and the hill is ascended by elegant steps. In this ceremony are introduced many usages contrary to the ancient Chinese doctrine concerning the sacrifice to heaven. On the day of the winter solstice are added the honours paid to the five planets, that is, to their spirit. These ceremonies added to the sacrifice to heaven are not very ancient. There are likewise honours to the first founders of the reigning dynasty. At several other times the emperor goes to *Tien tan* to perform a sacrifice to heaven, and to honour his deceased ancestors.

To the north of the Hill of Heaven is a large and high terrace, on which is a most magnificent hall in honour of *Chang ti*, or the sovereign Lord, and of his ancestors. On the frontispice of this hall the present Tartar emperors have caused an inscription to be placed to *Ap cai han*, or the Lord of heaven. To this Tartar inscription answers the Chinese character *Kien*; which has the same meaning as the character *Tien*, heaven; and it signifies the *Chang ti*, who is intended to be honoured in this hall. The tablet for the *Chang ti* is in a place, which shews, that the honour paid to *Chang ti* is of a different kind from the honour paid to ancestors.

Without the eastern gate of *King tching*, N°. 145, is *Ge tan*, or Hill of the Sun. At the vernal equinox the emperor sends hither a prince or great man to honour the sun, that is, the spirit of the sun. This inclosure, tho' elegant enough, has nothing very remarkable; nor is the ceremony very ancient.

Without the north gate of *King tching*, at N°. 183, is *Ti tan*, or the Hill of the Earth. At the summer

summer solstice the emperor goes thither to sacrifice to the earth on the hill. Many of the learned men at present distinguish this sacrifice in the *Ti tan* from the sacrifice in the *Tien tan*. But according to the doctrine of Confucius, the sacrifice to the earth has the same object as the sacrifice to heaven. In both the supreme Lord *Chang ti* is to be honoured. I do not know, whether the emperor adheres to the doctrine of Confucius, and whether he does not pretend to honour the earth, or spirit of the earth, by performing a sacrifice, which originally had for its object the *Chang ti*, as we are assured by Confucius. The inclosure of *Ti tan* is a vast one; but is not at all equal in beauty to the *Tien tan*.

Without the western gate of *King tching*, N°. 211, is *Yue tan*, the Hill of the Moon. At the autumnal equinox the emperor sends thither a prince or great man to honour the moon, or spirit of the moon. This ceremony is not very ancient. This inclosure is a neat one, and pretty large.

Between the two north gates of *King tching*, N°. 183 and 188, is a vast esplanade for the exercise of the troops both horse and foot.

To the north of this esplanade are two beautiful temples of idols for the lamas. These two monasteries are very elegant. The emperor and the Tartars *Mon gou* lay out great sums on these two monasteries and the two temples of the lamas.

In the year 1111 before Christ, *Ou ouang*, founder of the dynasty *Tchcou*, nominated his brother *Tchao kong* prince of *Yen*. *Yen* is the ancient name of a pretty extensive country, in which Peking stands. This prince of *Yen* built a city there, a league and half



half south-west of the city *King tching*. This city was called *Yen king*, or the court of *Yen*. It became afterwards considerable; and the prince of *Yen* very powerful in the country of *Petcheli* and *Leao tong*. In the year 222 before Christ the emperor *Tsin chi boang* destroyed the power of the princes of *Yen*, the descendants of *Tchao kong*, and seized their dominions. The founder of the dynasty *Han* destroyed the power of the family of *Tsin chi boang*. In the time of the dynasty *Tsin*, before the Christian æra, and of the dynasty *Han*, the city of *Yen* was an important government, on account of the neighbourhood of the Tartars. Some time after the dynasty *Han* several Tartar princes *Sien pi* made themselves masters of the country of *Yen*. During the dynasty of *Tang* the city of *Yen* was still a considerable one. After the destruction of that dynasty the Tartars *Ki tan*\* made themselves masters of Tartary, and the provinces of *Chanfy*, *Petcheli*, and *Leao tong*. Their power was formidable to the Chinese. Their court was in the city of *Yen*, which they adorned and enlarged. These Tartars had, like the Chinese emperors, tribunals; one for the mathematics, and another for history†. They had likewise some illustrious princes, and kept some correspondence with the Caliphs.

The Tartars *Nuntche* destroyed the power of *Leao*. Their court was also at *Yen*; and they made it as magnificent and large a city as Peking is now. The Mogol Tartars destroyed the empire of the

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\* This power is called in China the dynasty *Leao*.

† There is extant, in the Chinese and Tartar *Mantchesu* languages, an history of the dynasty of *Ki tan*.

*Nuntche* or *Kin*. Their court was at first at *Yen*, but the Tartar Mogol emperor *Koublay* demolished that city, and built what is now called *King tching*: at least *King tching* is a good part of the city built by *Koublay*, which was some *ly* larger. The emperor's palace was likewise larger.

This city *King tching* is that, which Marco Paul calls *Cambalu*. *Car* is *khan*, which signifies a *king*; and *balu* is a corruption of an old Mogol word *balag*, or *balab*, which signifies a *city*: whence is formed the word *balgasan* in Mogol or Mongou, which signifies city. *Khan balu*, or *khan balou*, signifies the royal city. *King tching*, in the time of Marco Paulo, was the capital of the empire of China. The Persians and Arabians, from the Mongou word *khan balou*, or *khan balgasun*, or *khan balga*, formed the word *khan balik* or *khan balek*, which signifies also the royal city. This name was given by the eastern people to the city of *Caifong fou*, the capital of *Honan*, and to that of *Nanking*, the capital of *Kiangnan*, at the time when these cities were the court of princes. This name was also given to the cities of Tartary, when some powerful princes kept sometimes their court there. What I have remarked concerning the words *khan balik*, *khan balek*, *khan balga*, &c. is to be applied to the words *ordo balik*, *ordou balik*. *Or do*, or *ordou*, or *orto*, signifies royal, imperial, in the Mogol or Mongou language. So *ordou balik* signifies a court, a royal city; and these words are in fact the names of some old cities, where the Mogol or Mongou kings kept their courts.

REMARKS on N<sup>o</sup>. 5, *Fan king tchang*; which is the place where the foreign classical books are kept.

*Tchang* signifies magazine, or large place, where any thing is contained. *Fan* signifies stranger or foreigner; and *king* signifies a classical book.

The Jews of *Caifong fou*, the capital of *Honan*, first told the Jesuit missionaries, that they conceived, that the Hebrew Bible was preserved at Peking in the place called *Fan king tchang*. These first missionaries neglected to make a search for it at Peking, or did not think of it. But it did not escape the attention of Father Bouvet, a French Jesuit, who went to *Fan king tchang*. The antient place, where the foreign books were kept, had been destroyed; and those books removed into a neighbouring *miao*, where there were bonzes. Father Bouvet went to this *miao* with two other French Jesuits; but they found only the Koran, fragments of the classical books of the Indians, and the classical books of the lamas; the whole in bad condition. Father Bouvet thought, that he saw in an old coffer Chaldee, Syriac, and Hebrew characters. The bonze would not shew the place, where Father Bouvet thought that he had seen those characters, which, on returning to the *miao*, were not found. The emperor had ordered the bonzes to shew every thing to Father Bouvet. All the classical books were afterwards removed to the palace; the *miao* was demolished; and there remained nothing but the name of *Fan king tchang*. When I passed thro' *Caifong fou*, the Jews, in the  
presence

presence of Father Gozani, who served me as interpreter, assured me, that I should find the Bible in the *Fan king tchang*. These Jews had not been at Peking. What they said was in consequence of what they had been told by old Jews, who were deceased. When I arrived at Peking, I made inquiries myself, and caused inquiries to be made by others ; but I could not find the Bible. It is not yet an hundred years since there were at Peking some Jewish families ; which afterwards turned Mahometans. A Mahometan, who was a man of parts, assured me several times, that the Bible was in the possession of the Mahometans here, whose ancestors were Jews. But when, in consequence of what he said, inquiries were made, nothing was found. This Mahometan informed me likewise, that he had made inquiries ; but if he had done so, his researches proved unsuccessful.

REMARKS on the *Ti ouang miao*, N<sup>o</sup>. 217.

1. The emperors, whose memory is honoured there, are

The emperors *Tou hi*, *Chin Nong*, *Hoang ti*.

The emperors *Chao hao*, *Tchouen hui*, *Ty co*, *Tao, Chun*.

The emperor *Tu*, the founder of the dynasty *Hia*, and thirteen other emperors of that dynasty.

The emperor *Tching tang*, the founder of the dynasty *Chang*, and twenty-five emperors of that dynasty.

The emperor *Ou ouang*, the founder of the dynasty *Tcheou*, and thirty-one emperors of that dynasty.

The founder of the dynasty *Han*, and twenty emperors of that dynasty, who are called western *Han*, eastern *Han*, and later *Han*.

The founder of the dynasty *Tang*, and fourteen emperors of that dynasty.

The founder of the dynasty *Song*, and thirteen emperors of that dynasty; which is called the northern *Song* and the southern *Song*.

*Gen tchis khan*, or *Temogin*, the founder of the dynasty *Yuen*, is the dynasty of the Mongol or Mogol Tartars. Besides the founder of this dynasty, there are ten other emperors of this dynasty, whose memory is honoured in the *Ti ouang miao*. The four first emperors of this dynasty, viz. *Gen tchis khan*, *Ogo tay*, *Kouey yevou*, and *Meng ko*, reigned in the northern provinces, and had not conquered all China. The emperor *Cobilay*, or *Koublay*, in Chinese *Yuen chitfou*, completed the conquest of China.

The founder of the dynasty *Ming*, and the eleven emperors of this dynasty.

The emperor *Ogo tay*, the second of the dynasty *Yuen*, completed the destruction of the dynasty of the eastern Tartars, called *Kin*. It reigned to the north as long as the dynasty *Song* reigned to the south. In the *Ti ouang miao* is honoured the memory of the founder of this dynasty *Kin*, and four other emperors of it.

The founder of the Tartar dynasty *Kin* destroyed the dynasty of the Tartars *Ki tan*, called *Leac*, which conquered a great part of North China and Tartary.

In the *Ti ouang miao* is honoured the memory of this Tartar dynasty *Leao*, and five other emperors of the Tartars *Ki tan*, whose country was in that of Parin in Tartary, among the Mongou or Mogols.

*Continuation of the Remarks on the Ti ouang miao.*

2. In the palace of Peking, and elfewhere, there are great halls, in which honours are paid to the memory of the deceased emperors of the reigning dynasty of the *Mantcheou*. The first and second emperor reigned in East Tartary. The emperor *Chuntchi* began to reign in China. If we reckon the present emperor in the number, there are six emperors *Mantcheou*. Father Couplet, and others, are mistaken in reckoning one more. This error was occasioned by the years of the reign of *Tay hong*, the second emperor, having had two names. Father Couplet, and others, took the two names of the years of the reign for the name or title of the two emperors.

3. In the *Ti ouang miao* is honoured the memory of some illustrious persons in the different dynasties. The same is done in the hall, where honour is paid to the memory of the deceased emperors *Mantcheou*. and there are there tablets for so many illustrious persons among those emperors.

4. In the *Ti ouang miao* are placed none of the emperors of the dynasty *Hin* before Christ, nor any of those between the dynasties *Tang* and *Han*, nor of those of the five small dynasties after that of *Tang*. Besides, in each dynasty there are some emperors, whose tablets are not placed in the *Ti ouang miao*. The reigning dynasty has not thought it a duty to pay honours to those emperors, but considered them as unworthy the pompous title of *Ti tse*, or *Sons of Heaven*.

5. The

5. The Tartars *Sien pi*, who came from the confines of *Leao tong* and Mongol or Mogol Tartary, had hords named *To pa*. One of these hords made themselves masters of Tartary *Leao tong*, and of several northern provinces of China. This Tartar power has the Chinese name of *Ouey*. It has produced several great princes. The year of Christ 386 is reckoned the first of that dynasty \*, which reigned above 180 years. I do not know why the reigning dynasty has not placed the name of any of these emperors in the *Ti ouang miao*.

6. If we suppose, first, that all the books of the history of China should be lost, or the contents of them should not be known in Europe ; and secondly, that the catalogue of the emperors, who are mentioned in the *Ti ouang miao*, should fall into the hands of some European critics ; it is probable, that such a catalogue would occasion many false reasonings with relation to the succession of the emperors, who have reigned in China.

Of which dynasty there is extant a very curious history.

XCVII. *An Attempt to improve the Manner of working the Ventilators by the Help of the Fire-Engine. In a Letter to Tho. Birch, D. D. Secret. R. S. from Keane Fitz-Gerald, Esq; F. R. S.*

S I R,

Read June 8, 1758. **T**HE reverend and ingenious Dr. Hales, from whom mankind has received such benefit by his useful application of ventilators, being inclined to extend its use to those, who work in mines at great depths under ground, where the lives of many are lost by damps and noxious vapours, occasioned by the want of a free circulation of air; and finding by experience, that ventilators worked by wind do not operate above one third part of the year, and in calm hot weather, when most wanted, do not operate at all; did me the honour of applying to me for assistance in contriving a machine to work the ventilator, by the help of the fire-engine, which is now generally used in all mines for drawing off the water; and which I have accordingly attempted, and hope it will answer the purpose.

As the lever of the fire-engine works up and down alternately, and performs at a common medium about a dozen strokes in a minute, it was necessary to contrive some way to make the beam, tho' moving alternately, to turn a wheel constantly round one way, and also to increase the number of strokes to fifty or sixty in a minute.

The



The model of a machine for this purpose is composed of four wheels of different sizes, two clicks, three pinions, and a fly; which is put into motion by the part of a wheel fixed to the arch of the lever of the fire-engine.

The wheel, which is turned by the lever, or rather moved up and down by it, is loose on its arbor; and likewise one of the rockets, and the wheel next to it. The outside rocket and outside wheel are fixed on the arbor.

There are two pinion-wheels fixed on the arbor; one on each side, near the edge of the wheel moved by the lever, which turns them.

There are also two clicks; one fixed to the great wheel, the other to the frame. These exclusive of the wheel that moves the fly.

The effect is, When the lever moves the wheel downwards, its click forces the rocket fixed on the arbor to move along with it, and the other wheels the same way. When it moves upwards, the click fixed on the frame stops the larger rocket, and the wheel next to it, which are pinned together. This wheel being stopped, and the great wheel carried upwards by the lever, the pinion towards the edge of the great wheel is forced round it, and moves the pinion on the other side the great wheel; which pinion moves the wheel fixed on the arbor, the contrary way to the great wheel, which is carried upwards by the lever. By which means, the arbor is constantly turned the same way, when the lever of the fire-engine is moved either upwards, or downwards.

Upon the arbor there is also another great wheel fixed, which turns a pinion: on the arbor of which  
pinion

pinion is a crank to move the ventilator, and also a fly fixed to the end, to help the motion of the crank, which in the model is turned three times for each stroke of the lever, and may be increased or diminished, according to the number of teeth in the pinion.

The number of teeth in the great wheel moved by the lever is sixty-six; but need not have teeth above half way round.

The wheel fixed to the rochet has thirty-three teeth, and its pinion eleven.

The wheel fixed on the arbor, on the outside, has twenty-four teeth, and its pinion sixteen.

The wheel, which turns the fly, has ninety teeth, and the pinion turn'd by this wheel ten.

The greater the number of teeth in the rochets, the better.

This machine may also be applied to other useful purposes at mines; and it may be easily made to turn a mill to grind corn; or to turn a wheel to raise coals, or whatever else is wanted to be raised from the mines. As I have not met with any thing of the kind described, I take the liberty of desiring you to lay it before the Society; and I hope it may be made some way useful to the public.

I am, Sir,

Your most obedient humble Servant,

Poland-Street,  
June 7th, 1758.

Kea. Fitz-Gerald.

*Explanation of the Three Tables.*

The wheel A (*Tab. 26.*), which is turned by the lever B (*Tab. 27.*), or rather moved up and down by it, is loose on its arbor; and likewise one of the rochets C (*Tab. 26.*), and the wheel next to it D. The outside rochet E, and outside wheel F, are fixed on the arbor.

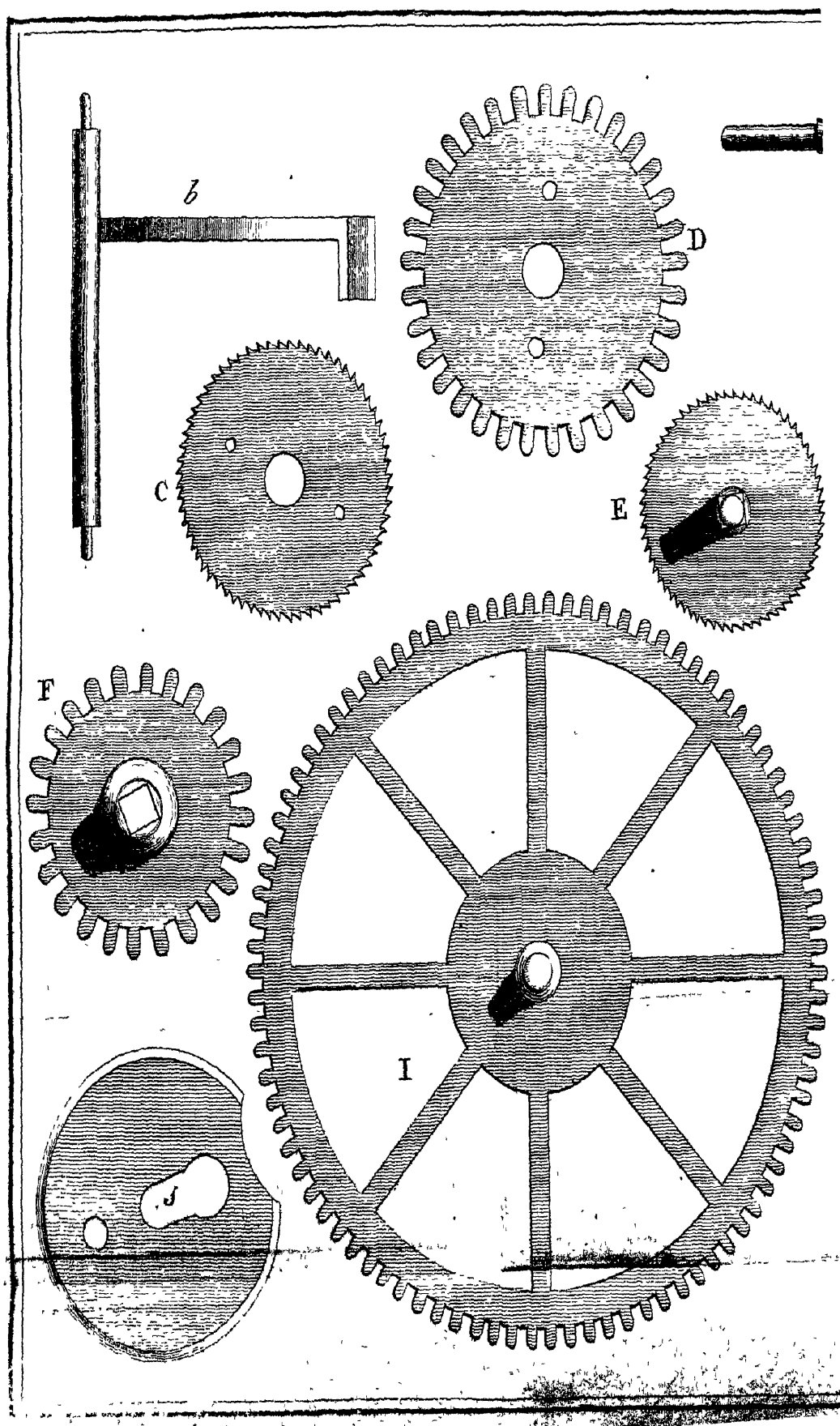
There are two pinion-wheels G and H fixed on one arbor; one on each side, near the edge of the wheel A, moved by the lever.

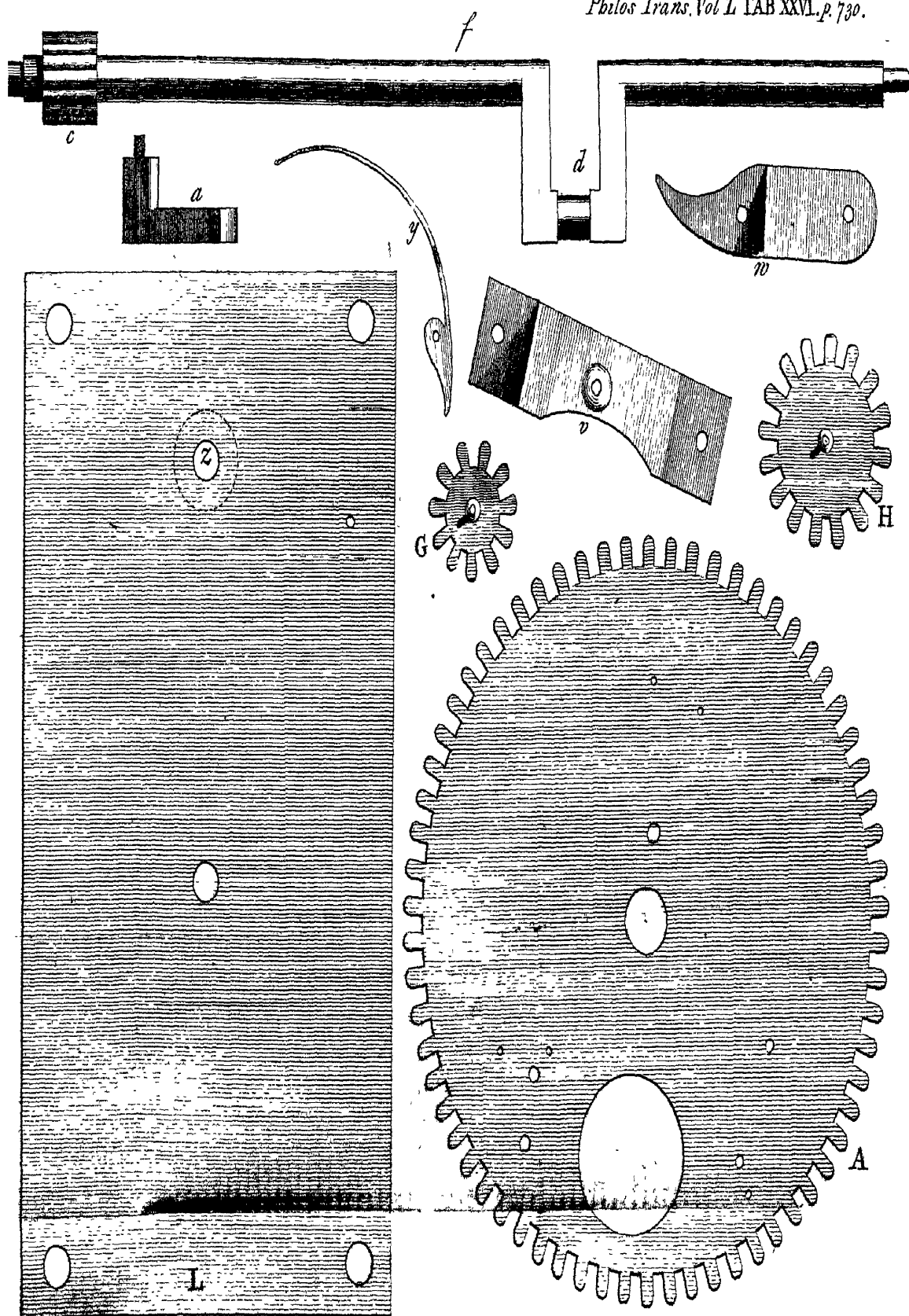
There are also two clicks *a* and *b*; one *a* fixed to the great wheel A, the other *b* fixed to the frame. These exclusive of the wheel I, that moves the pinion *c*, on the arbor of which, the crank *d*, and fly *e*, (*Tab. 27.*) are fixed.

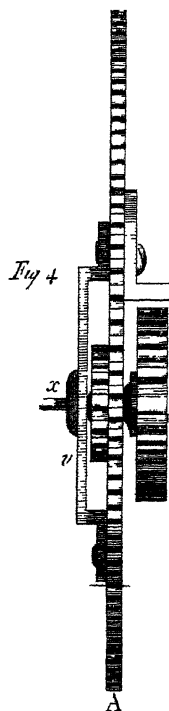
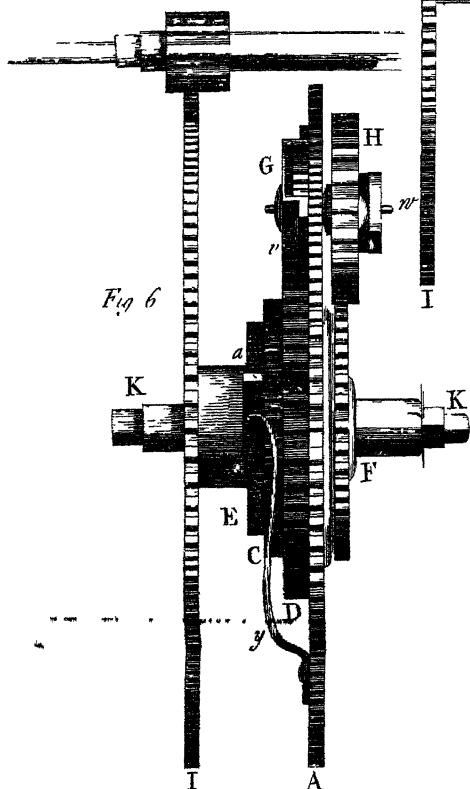
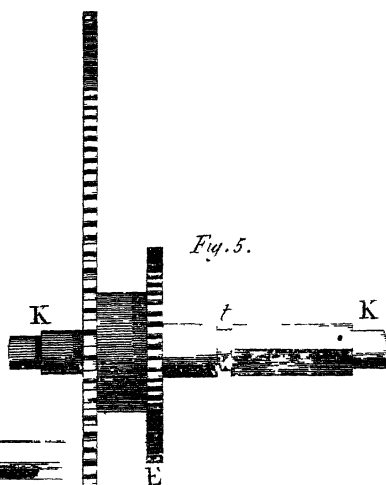
The effect is, when the lever B moves the wheel A downwards; its click *a*, forces the rochet E, fixed on the arbor K, to move along with it, and the other wheels the same way. When it moves upwards, the click *b* fixed to the frame, stops the larger rocket C, and the wheel D next to it, which are pinned together; and as the wheel A is carried upwards by the lever, the pinion G towards the edge of it, is forced round the wheel D, and moves the pinion H, on the other side the great wheel A, which moves the wheel F fixed on the arbor K, the contrary way to the wheel A. By which means, the arbor K is constantly turned the same way, when the lever of the fire-engine moves either upwards, or downwards.

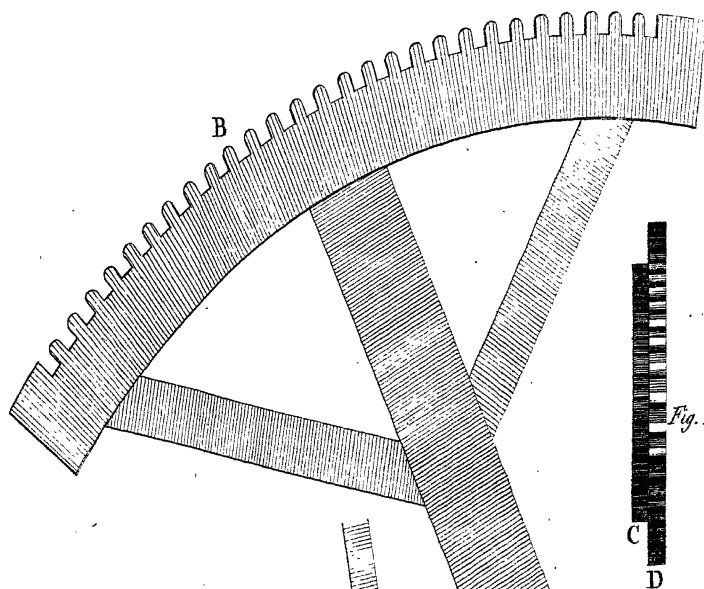
The pinion G, by being made proportionally smaller than the pinion H, keeps the arbor K in the  
same



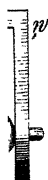








*Fig. 1.*



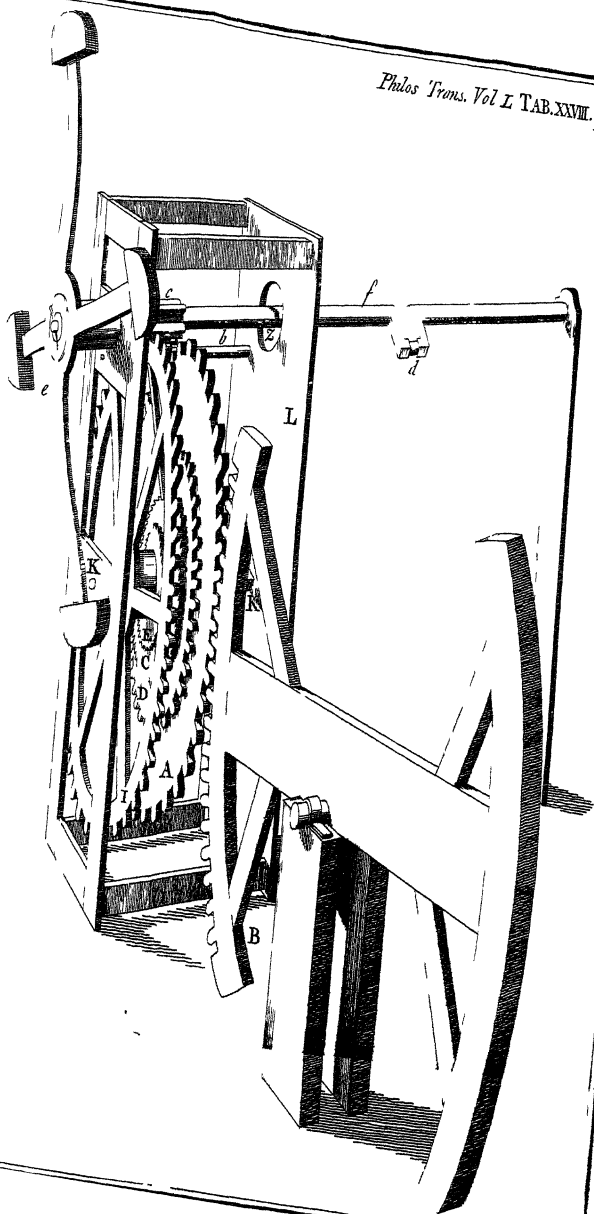
*Fig. 3.*



*Fig. 2.*









same swiftness of motion, when the lever is moved upwards, as downwards.

The great wheel I, fixed on the arbor K, turns the pinion *c*, on the arbor of which the crank *d* (to move the ventilator), and the fly *e* (to help the motion), are fixed. The pinion *c*, is turned three times by each alternate motion of the lever; which may be increased, or diminished, according to the number of teeth in the pinion *c*.

The number of teeth in the wheel A is sixty-six, but need not be toothed above half way. Instead of this wheel there might be a barrel, with a chord round it, fixed at each end of the arch of the lever, and projecting somewhat from it; which, by the motion of the lever, would work in the same manner in other respects, and be easier made, and at less expence.

The wheel D fixed to the rochet C has thirty-three teeth, and its pinion G eleven.

The wheel F fixed on the arbor K has twenty-four teeth, and its pinion H sixteen.

The greater the number of teeth in the rochets, the better.

*Tab. 26.* contains the plan (in parts) of the whole machine, except the lever B and fly *e*, which are in *Tab. 27.*

*Tab. 27.* also contains the elevation of the arbor, with its different fixtures; *viz.*

- Fig. 1.* The rochet C and wheel D (*Tab. 26.*) fixed together.
2. The outside wheel F that works the pinion-wheel H (*Tab. 26.*).

- Fig. 3.* The two pinion-wheels H and G (*Tab. 26.*) fixed on their arbor.
4. The same fixed to the wheel A (*Tab. 26.*) by means of two cocks *u* and *w* (*Tab. 26.*).
5. The arbor, with the wheel L and rochet E fixed; *t* the place, where the wheel A is fixed.
6. The elevation of the whole arbor.

*Tab. 28.* The elevation of the whole machine, the lever B (*Tab. 27.*) working the wheel A (*Tab. 26.*).

*s* (*Tab. 26.*) a thin piece of metal screwed to the wheel A, to keep it in its place *t* on the arbor K (*Tab. 27.*)

*u* (*Tab. 26.*) the cock, that fastens the pinion G, to the inside of the wheel A.

*w* (*Tab. 26.*) the cock, that fastens the pinion H on the outside of the wheel A.

*x* (*Tab. 27.*) the arbor, on which the pinions G and H are fixed.

*y* (*Tab. 26.*) a spring, that keeps the click *a* in its place.

L (*Tab. 26.*) a frame-plate with the centers marked.

*z* The opposite hole enlarged, to admit the pinion *c* to pass through.

XCVIII. *An Account of some Experiments concerning the different Refrangibility of Light.* By Mr. John Dollond. *With a Letter from James Short, M. A. F. R. S. Acad. Reg. Suec. Soc.*

*To the Rev. Dr. Birch, Secret. R. S.*

Dear Sir,

Read June 8, 1758. **I** Have received the inclosed paper from Mr. Dollond, which he desires may be laid before the Royal Society. It contains the theory of correcting the errors arising from the different refrangibility of the rays of light in the object-glasses of refracting telescopes; and I have found, upon examination, that telescopes made according to this theory are intirely free from colours, and are as distinct as reflecting telescopes. I am,

Dear Sir,

Surrey-street,  
8th June, 1758.

Your most obedient humble Servant,

Ja. Short.

**I**T is well known, that a ray of light, refracted by passing thro' mediums of different densities, is at the same time proportionally divided or spread into a number of parts, commonly called homogeneal rays, each of a different colour; and that these, after refraction, proceed diverging: a proof, that they are differently

differently refracted, and that light consists of parts that differ in degrees of refrangibility.

Every ray of light passing from a rarer into a denser medium, is refracted towards the perpendicular; but from a denser into a rarer one, from the perpendicular; and the sines of the angles of incidence and refraction are in a given ratio. But light consisting of parts, which are differently refrangible, each part of an original or compound ray has a ratio peculiar to itself; and therefore the more a heterogeneous ray is refracted, the more will the colours diverge, since the ratios of the sines of the homogeneous rays are constant; and equal refractions produce equal divergencies.

That this is the case when light is refracted by one given medium only, as suppose any particular sort of glass, is out of all dispute, being indeed self-evident; but that the divergency of the colours will be the same under equal refractions, whatsoever mediums the light may be refracted by, tho' generally supposed, does not appear quite so clearly.

However, as no medium is known, which will refract light without diverging the colours, and as difference of refrangibility seems thence to be a property inherent in light itself, Opticians have, upon that consideration, concluded, that equal refractions must produce equal divergencies in every sort of medium: whence it should also follow, that equal and contrary refractions must not only destroy each other, but that the divergency of the colours from one refraction would likewise be corrected by the other; and there could be no possibility of producing any such thing as refraction, which would not be affected  
by

by the different refrangibility of light ; or, in other words, that however a ray of light might be refracted backwards and forwards by different mediums, as water, glass, &c. provided it was so done, that the emergent ray should be parallel to the incident one, it would ever after be white ; and, conversely, if it should come out inclined to the incident, it would diverge, and ever after be coloured. From which it was natural to infer, that all spherical object-glasses of telescopes must be equally affected by the different refrangibility of light, in proportion to their apertures, whatever material they may be formed of.

But it seems worthy of consideration, that notwithstanding this notion has been generally adopted as an incontestable truth, yet it does not seem to have been hitherto so confirmed by evident experiment, as the nature of so important a matter justly demands ; and this it was that determined me to attempt putting the thing to issue by the following experiment.

I cemented together two plates of parallel glass at their edges, so as to form a prismatic or wedge-like vessel, when stopped at the ends or bases ; and its edge being turned downwards, I placed therein a glass prism with one of its edges upwards, and filled up the vacancy with clear water : thus the refraction of the prism was contrived to be contrary to that of the water, so that a ray of light transmitted thro' both these refracting mediums would be refracted by the difference only between the two refractions. Wherefore, as I found the water to refract more or less than the glass prism, I diminished

or



or increased the angle between the glass plates, till I found the two contrary refractions to be equal; which I discovered by viewing an object thro' this double prism; which, when it appeared neither raised nor depressed, I was satisfied, that the refractions were equal, and that the emergent rays were parallel to the incident.

Now, according to the prevailing opinion, the object should have appeared thro' this double prism quite of its natural colour; for if the difference of refrangibility had been equal in the two equal refractions, they would have rectified each other: but the experiment fully proved the fallacy of this received opinion, by shewing the divergency of the light by the prism to be almost double of that by the water; for the object, tho' not at all refracted, was yet as much infected with prismatic colours, as if it had been seen thro' a glass wedge only, whose refracting angle was near 30 degrees.

*N. B.* This experiment will be readily perceived to be the same as that which Sir Isaac Newton mentions\*; but how it comes to differ so very remarkably in the result, I shall not take upon me to account for; but will only add, that I used all possible precaution and care in the process, and that I keep the apparatus by me to evince the truth of what I write, whenever I may be properly required so to do.

I plainly saw then, that if the refracting angle of the water-vessel could have admitted of a sufficient

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\* Book I. Part ii. Prop. 3. Experiment 8. of his Optics.

increase, the divergency of the coloured rays would have been greatly diminished, or intirely rectified; and there would have been a very great refraction without colour, as now I had a great discolouring without refraction: but the inconveniency of so large an angle, as that of the vessel must have been, to bring the light to an equal divergency with that of the glass prism, whose angle was about 60 degrees, made it necessary to try some experiments of the same kind, by smaller angles.

I ground a wedge of common plate glass to an angle of somewhat less than 9 degrees, which refracted the mean rays about 5 degrees. I then made a wedge-like vessel, as in the former experiment, and filling it with water, managed it so, that it refracted equally with the glass wedge; or, in other words, the difference of their refractions was nothing, and objects viewed thro' them appeared neither raised nor depressed. This was done with an intent to observe the same thing over again in these small angles, which I had seen in the prism: and it appeared indeed the same in proportion, or as near as I could judge; for notwithstanding the refractions were here also equal, yet the divergency of the colours by the glass was vastly greater than that by the water; for objects seen by these two refractions were very much discoloured. Now this was a demonstration, that the divergency of the light, by the different refrangibility, was far from being equal in these two refractions. I also saw, from the position of the colours, that the excess of divergency was in the glass; so that I increased the angle of the water-wedge, by different trials, till the divergency of the

light by the water was equal to that by the glass, that is, till the object, tho' considerably refracted, by the excess of the refraction of the water, appeared nevertheless quite free from any colours proceeding from the different refrangibility of light; and, as near as I could then measure, the refraction by the water was about  $\frac{1}{4}$  of that by the glass. Indeed I was not very exact in taking the measures, because my business was not at that time about the proportions, so much as to shew, that the divergency of the colours, by different substances, was by no means in proportion to the refractions; and that there was a possibility of refraction without any divergency of the light at all.

Having, about the beginning of the year 1757, tried these experiments, I soon after set about grinding telescopic object-glasses upon the new principles of refractions, which I had gathered from them; which object-glasses were compounded of two spherical glasses with water between them. These glasses I had the satisfaction to find, as I had expected, free from the errors arising from the different refrangibility of light: for the refractions, by which the rays were brought to a focus, were every-where the differences between two contrary refractions, in the same manner, and in the same proportions, as in the experiment with the wedges.

However, the images formed at the foci of these object-glasses were still very far from being so distinct as might have been expected from the removal of so great a disturbance; and yet it was not very difficult to guess at the reason, when I considered, that the radii of the spherical surfaces of those glasses  
were

were required to be so short, in order to make the refractions in the required proportions, that they must produce aberrations, or errors, in the image, as great, or greater, than those from the different refrangibility of light. And therefore, seeing no method of getting over that difficulty, I gave up all hopes of succeeding in that way.

And yet, as these experiments clearly proved, that different substances diverged the light very differently, in proportion to the refraction; I began to suspect, that such variety might possibly be found in different sorts of glass, especially as experience had already shewn, that some made much better object-glasses, in the usual way, than others: and as no satisfactory cause had as yet been assigned for such difference, there was great reason to presume, that it might be owing to the different divergency of the light by their refractions.

Wherefore, the next business to be undertaken, was to grind wedges of different kinds of glass, and apply them together, so that the refractions might be made in contrary directions, in order to discover, as in the foregoing experiments, whether the refraction and divergency of the colours would vanish together. But a considerable time elapsed before I could set about that work; for tho' I was determined to try it at my leisure, for satisfying my own curiosity, yet I did not expect to meet with a difference sufficient to give room for any great improvement of telescopes; so that it was not till the latter end of the year that I undertook it, when my first trials convinced me, that this business really deserved my utmost attention and application.

I discovered a difference, far beyond my hopes, in the refractive qualities of different kinds of glass, with respect to their divergency of colours. The yellow or straw-coloured foreign sort, commonly called Venice glass, and the English crown glass, are very near alike in that respect, tho' in general the crown glass seems to diverge the light rather the least of the two. The common plate glass made in England diverges more; and the white crystal or flint English glass, as it is called, most of all.

It was not now my business to examine into the particular qualities of every kind of glass that I could come at, much less to amuse myself with conjectures about the cause, but to fix upon such two sorts as their difference was the greatest; which I soon found to be the crown, and the white flint or crystal. I therefore ground a wedge of white flint of about 25 degrees, and another of crown of about 29 degrees, which refracted nearly alike; but their divergency of the colours was very different. I then ground several others of crown to different angles, till I got one, which was equal, with respect to the divergency of the light, to that in the white flint: for when they were put together, so as to refract in contrary directions, the refracted light was intirely free from colour. Then measuring the refractions of each wedge, I found that of the white glass to be to that of the crown nearly as 2 to 3; and this proportion would hold very nearly in all small angles. Wherefore any two wedges made in this proportion, and applied together, so as to refract in a contrary direction, would refract the light without any difference of refrangibility.

To make therefore two spherical glasses, that shall refract the light in contrary directions, it is easy to understand, that one must be concave, and the other convex; and as the rays are to converge to a real focus, the excess of refraction must evidently be in the convex; and as the convex is to refract most, it appears from the experiment, that it must be made with crown glass, and the concave with white flint glass.

And further, as the refractions of spherical glasses are in an inverse ratio of their focal distances; it follows, that the focal distances of the two glasses should be inversely as the ratio's of the fractions of the wedges: for being thus proportioned, every ray of light, that passes thro' this combined glass, at whatever distance it may pass from its axe, will constantly be refracted, by the difference between two contrary refractions, in the proportion required; and therefore the different refrangibility of the light will be intirely removed.

Having thus got rid of the principal cause of the imperfection of refracting telescopes, there seemed to be nothing more to do, but to go to work upon this principle: but I had not made many attempts, before I found, that the removal of one impediment had introduced another equally detrimental (the same as I had before found in two glasses with water between them): for the two glasses, that were to be combined together, were the segments of very deep spheres; and therefore the aberrations from the spherical surfaces became very considerable, and greatly disturbed the distinctness of the image. Tho' this appeared at first a very great difficulty, yet I was  
not

not long without hopes of a remedy: for considering, the surfaces of spherical glasses admit of great variations, tho' the focal distance be limited, and that by these variations their aberrations may be made more or less, almost at pleasure; I plainly saw the possibility of making the aberrations of any two glasses equal; and as in this case the refractions of the two glasses were contrary to each other, their aberrations, being equal, would intirely vanish.

And thus, at last, I obtained a perfect theory for making object-glasses, to the apertures of which I could scarce conceive any limits: for if the practice could come up to the theory, they must certainly admit of very extensive ones, and of course bear very great magnifying powers.

But the difficulties attending the practice are very considerable. In the first place, the focal distances, as well as the particular surfaces, must be very nicely proportioned to the densities or refracting powers of the glasses; which are very apt to vary in the same sort of glass made at different times. Secondly, the centres of the two glasses must be placed truly on the common axis of the telescope, otherwise the desired effect will be in a great measure destroyed. Add to these, that there are four surfaces to be wrought perfectly spherical; and any person, but moderately practised in optical operations, will allow, that there must be the greatest accuracy throughout the whole work.

Notwithstanding so many difficulties, as I have enumerated, I have, after numerous trials, and a resolute perseverance, brought the matter at last to such an issue, that I can construct refracting telescopes,

scopes, with such apertures and magnifying powers, under limited lengths, as, in the opinion of the best and undeniable judges, who have experienced them, far exceed any thing that has been hitherto produced, as representing objects with great distinctness, and in their true colours.

John Dollond.

XCIX. *An Account of some extraordinary Effects arising from Convulsions; being Part of a Letter to John Huxham, M.D. and F.R.S. from William Watson, M.D. F.R.S.*

6 June, 1758.

Read June 15.  
1758.

**I**N the month of January 1757, I was concerned for a young gentlewoman, who, if the number, continuance, and frequency of their returns, be considered, suffered the most violent and severe convulsions I ever knew. At some times the muscular spasms were general; at other times single muscles only, or a number of them, subservient to some particular purpose in the animal oeconomy, were affected. And such was the peculiarity of this case, that after and in proportion as any single muscle, or any determined number of muscles, had been in a state of spasm, a paralytic inability succeeded to those muscles, which very much disordered and impaired, and several times even for no small continuance prevented the patient



from performing, several of her necessary functions. When the muscles, for instance, subservient to deglutition had been convulsed, for many hours after the fits had left her, she has not been able to swallow a single drop of liquid: so that when attempts have been made to cause her to drink, unless the liquor was immediately thrown back, there was imminent danger of her being strangled. When her eyes have been affected, several times a compleat *gutta serena*, and total blindness, has ensued; the patient being able to bear the strong day-light with open eyes, without being sensible of its influence, or in the least contracting her widely dilated pupils. After one of these fits the blindness continued full five days; and I began to be in fear for the return of her sight.

You, Sir, who are so excellently well versed in the animal oeconomy, are not to be informed, that vocification is performed in the *aspera arteria*; but that the articulation of sounds into syllables and words is modulated principally by the tongue, and muscles about the larynx. In the case before you, very early in the disease, the spasms seized the muscles about the larynx: the consequence of which was, that after they were over, the patient was unable to utter a word. This faculty however she again once recovered; but it continued a very short time, as the fits returned, which again left her deprived of the power of speech. After having lost her voice a second time, her power of speech did not return, even after she was freed from her convulsions, and her general health restored. Fourteen months passed, whilst this patient continued absolutely speechless; when,

when, after having violently heated herself by four hours dancing, on a sudden her power of speech returned, and it has continued perfectly free ever since.

What is still further remarkable in this case is, that during the whole time of this patient's continuing speechless, her life was rendered yet more uncomfortable by her having, from the injury to her brain by the spasms, forgot how to write, so as to express her meaning that way: but upon the recovery of her speech, this faculty likewise returned, which she has retained ever since. During the severity of this disease, which continued several weeks, almost every day of which, from the number and violence of the convulsions, I feared would be the patient's last, nothing was left unattempted, which I imagined could tend to prevent the return of the spasms, or lessen their effects. My endeavours so far happily succeeded, that her fits did not return; but the consequences of them continued, more particularly her inability to speak. After some months however, when she was recruited in her strength, I was desirous of trying the effects of electricity, more particularly applied about her throat. This was accordingly attempted; but such was the state of her nerves, and their sensibility to its effects, that electrizing brought back the fits, which again affected her sight: so that I was compelled to desist, lest, in endeavouring to restore her speech, I might not only fail in this attempt, but might bring possibly on a permanent blindness. I determined therefore to trust the whole to time, which has happily removed all her complaints.

*C. An Account of an extraordinary Storm of Hail in Virginia. By Francis Fauquier, Esq; Lieutenant Governor of Virginia, and F. R. S. Communicated by William Fauquier, Esq; F. R. S.*

*To the Rev. Tho. Birch, D. D. Secret. R. S.*

S I R,

Read Nov. 9, 1758. **I**N a letter I received from my brother, the lieutenant governor of Virginia, he gives an account of a very remarkable storm of hail; which, if you think it worth communicating to the Society, is very much at their service.

It happened on Sunday the 9th of July, about four o'clock in the afternoon, and was preceded by some thunder and lightning. It was a small cloud, that did not seem to threaten much before its breaking, and did not extend a full mile in breadth. It passed over the middle of the town of Williamsburgh, and the skirts of the town had but little of it. Its course was from N. by W. to S. by E. The hailstones, or rather pieces of ice, were most of them of an oblong square form; many of them an inch and half long, and about three fourths of an inch wide and deep; and from one side of most of them there proceeded sharp spikes, protuberant at least half an inch. He says he cooled his wine, and froze cream, with some of them the next day; and they were not totally dissolved when he went to bed on  
Monday

Monday night. This storm broke every pane of glass on the north side his house, and destroyed all his garden things intirely.

He mentions likewise the heats to have been rather more than usual in that country this summer; and particularly on the 9th of August his thermometer (which is hung on the outside of his house on the north aspect) was at 97, by Fahrenheit's graduation, and some other days as high as 94 or 95. I am,

S I R,

Your most obedient humble Servant,

Jermyn-street,  
18 October, 1758.

Wm. Fauquier.

CI. *An Account of an extraordinary Case of a diseased Eye: In a Letter to Matthew Maty, M. D. F. R. S. By Daniel Peter Layard, M. D. F. R. S.*

Dear Sir,

Huntingdon, 20th May, 1758.

Read Nov. 9. 1758. **I**N October 1755. I communicated to you, and you inserted in the last volume of your *Journal Britannique*, the case of Sufannah Earle, of Hemmingford-Grey in this County, who, in consequence of the whooping cough, was afflicted with a protruded eye. The case I now send you, somewhat similar to that young girl's in its first appearance and progress, but by accident attended with a second disease, will perhaps deserve your attention,

tention, and not seem unworthy of being presented to the Royal Society.

John Law, of Fenny-Stanton, also in the County of Huntingdon, a strong and robust lad, thirteen years and six months old, in Easter week 1756, beating dung about a close with unusual force, on a sudden felt a violent pain in his left eye. The pain increased, an inflammation ensued, and the eye grew daily larger. The poor boy's mother followed the directions, which she received, without the least benefit to her child, after having, besides other expences, been defrauded by a quack of two guineas; a great sum for a poor cottager!

The widow Law, in her distress, heard of Sufannah Earle's cure. She went to see her; and determined to bring her son to Huntingdon, for Mr. Hopkins's assistance. Accordingly, October the 7th 1756, she came to Mr. Daniel Hopkins, surgeon, in this town; and having desired my opinion, we both examined the eye together.

The left eye was protruded out of its orbit, and hung down over the cheek to the upper lip. The coats were greatly discoloured, all the vessels turgid, the sight totally lost, and the humours appeared like fluctuating pus. We saw the necessity of an immediate extirpation, to save the right eye, already greatly inflamed; and having apprized the mother and boy of the state the eye was in, a consultation was desired with two surgeons of St. Ives. Mr. Dawkes, who was present with Mr. Skeeles at Sufannah Earle's operation, being dead since that time, Mr. Thomas Skeeles and Mr. Thomas Want very charitably met Mr. Hopkins and me the next day, October the 8th, at the widow Law's cottage.

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The eye appeared to these gentlemen as I have related : and upon Mr. Want's pressing with his finger on the pupil, the globe burst at the edge of the *Iris*, and discharged pus. The extirpation of the eye was unanimously agreed upon, and immediately performed.

Mr. Hopkins made a puncture with a lancet close to the external and small canthus of the eye, and then with a pair of crooked scissars took off all the distended globe close to the eye-lids. He then cleaned the cavity of the purulent humours, and filled it with soft lint, over which he applied bolsters dipped in warm red wine and water, and the *monoculus* bandage to keep on the whole dressings. The lad was bled in the arm ; nitrous medicines, and anodynes, were prescribed, and a suitable regimen. The fever, and inflammation of the eye, gradually decreased ; the suppuration of the wound in few days was good, the distended eye-lids contracted, and a cure was soon expected.

But on November the 7th the lad went to open the street-door, and it being a cold and rainy evening, he quickly felt the bad effects of the cold wind, which drove the rain in upon him. That night the wound became again very painful, the eye-lids puffed up, and next day appeared much inflamed, as were all the contents of the orbit. Fungous excrescences soon followed, and an intermittent fever. An emetic being improper, he was purged with rhubarb, and afterwards took the bark infused in red wine. The fever was removed after some time ; but the contents of the orbit continued increasing, and the fungous excrescences became so large and spongy, as to be of  
equal

equal bulk with the diseased eye before extirpation. All topical applications, to contract this fungus, were ineffectual, and the application of caustics or escharotics was prudently avoided, lest they should produce a carcinomatous ulcer. The discharge was chiefly a purulent serum: on which account, ever since the beginning of November he was kept upon a dry diet.

In February 1757. the remaining coats of the eye began to appear at the most prominent parts of the excrescence, and seemed white like a part of the *conjunctiva*. On touching it with the finger, a distinct fluctuation was felt, and an *hydrophthalmia* perfectly discovered; but neither the thickness of the coats, nor the sensibility of the parts, would permit a puncture to be made, till the cyst, which appeared formed by the distension of one of the coats of the eye, was freer from the fungus.

The cyst continued daily to extend itself, and to separate the fungous edges; the fluctuation became more manifest, and the membranes thinner. At length, on the 15th of June 1757, Mr. Hopkins opened the cyst with the point of a lancet, and let out a large cup-full of limpid serum, without smell or taste. The boy felt very little pain in this operation. The cavity was filled with dry lint, and compresses dipt in warm red wine and water were applied over it. All the night following, and several days after, a great discharge of serum came away. On the 19th the fungus was considerably lessened. Mr. Hopkins then dressed the wound with warm *unguentum é gummi elemi*, and washed the fungus with a lotion of *aquarum calcis, rosarum, et tincturæ*

*tura myrrhæ.* On the 23d, upon his removing the dressings, he saw the cyst loose and collapsed; which he extracted with his forceps, without the least difficulty, or pain to his patient. The fungus daily wasted afterwards, the wound digested well, and the lad was intirely cured on the 7th of August.

His right eye is perfectly strong, and he has been free from complaint ever since. The remainder of the coats of the eye, and of the muscles, bear up the eye-lids, that when uncovered he only seems to have closed the left eye: however, he has wore all the winter a black patch over it, to guard against fresh cold.

The cyst, when first taken away, measured three inches and half in length, one inch and half in diameter, and contained a large cup-full of water. It appeared to be the *tunica sclerotica*, was of a clear pellucid white, and of so delicate a texture, as scarce to admit of being touched without tearing; and when dried with all possible care, became so brittle, that Mr. Hopkins could hardly preserve it in the manner I now send it.

## R E M A R K S.

In both Susannah Earle and John Law's cases, the eye was distended by the accumulation of the aqueous humour, separated in great quantity by the repeated straining of the blood-vessels in the whooping cough, which might gradually relax and enlarge the aqueous ducts of Susannah Earle's eye; and possibly by the rupture of those ducts, and of some blood-vessels, at the time John Law exerted himself violently in beating

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ing dung about the cloſe : for in either caſe the *impetus* of the blood muſt have been ſo violent, as to produce thoſe effects. However, from the *hydrophthalmia* ſucceeding the operation on John Law, the fungous excreſcence, and continual ſerous diſcharge during ſeveral months from the wound, it plainly appears, that an abundance of aqueous humour was diſcharged at firſt by the diſtenſion or laceration of the aqueous ducts, and latterly for want of a contraction of thoſe veſſels, and of the lymphatics, which were no longer of uſe.

Both theſe caſes ſhew the neceſſity of inquiring particularly into the cauſes of diſeaſes of the eyes, as well as of other parts of the body ; for by barely attending to the ſymptoms, the diſeaſe will not be removed, tho' the ſymptoms be alleviated. Bleeding, and moderate evacuations, would certainly have, at firſt, decreaſed the tenſion and pain, and aſſuaged the inflammation ; but both topical applications, and internal medicines, were properly to be adapted, and a ſuitable diet regulated.

Not to mention the abſurd and impertinent abuſe of empirics, what benefit could accrue, in both theſe caſes, from unctuous, laxative, or emollient applications, from draſtic and mercurial purges ? Tho' ſuch applications might be well intended, to take off the tenſion and inflammation ; yet, as the diſtenſion of the blood-veſſels only increaſed gradually, as the globe of the eye was enlarged ; ſo whatever application relaxed the coats of the eye, muſt infallibly ſtretch out the veſſels yet farther, and cauſe a greater pain and inflammation ; which draſtic and mercurial purges would alſo increaſe.

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The only method then to be pursued in such bad cases would be at first to endeavour to remove the fullness of the blood, and make use of such topical remedies as would contract without irritation. If the cause remains, as the whooping cough in Sufannah Earle's case, no amendment of the eye can be expected, while the patient's blood-vessels are continually strained by frequent coughing. This illness therefore should be attended to, and removed as soon as possible.

But should the eye be so enlarged, as to protrude itself out of the orbit, there seems no other way to lessen the bulk of the eye, than by making a puncture with a proper instrument, to let out the aqueous humour; and then apply such agglutinant and contracting *collyria*, as may reduce the distended coats and vessels to their former size. This operation should be performed before the humours are vitiated, the sight lost, the vessels in a state of suppuration, and the coats of the eye too far extended; for at that time nothing less than extirpation can be of use.

Professor Nuck, in his *Tractatus de Duëtibz Oculorum Aquosis*, p. 120, & seq. relates the success he had in curing a young man by five repeated punctures, and a strict observance in a proper use of all the non-naturals.

I am, with the greatest regard and esteem,

Dear Sir,

Your most affectionate Brother,

and very humble Servant,

D. P. Layard.

CII. *An Account of the Heat of the Weather in Georgia: In a Letter from his Excellency Henry Ellis, Esq; Governor of Georgia, and F. R. S. to John Ellis, Esq; F. R. S.*

Dear Sir,

Georgia, 17 July, 1758.

Read Nov. 16, 1758. **T**H O' some weeks have passed since I wrote to you, yet so little alteration has happened in the state of our affairs, that nothing occurs to me relative to them worth committing to paper. This indeed I need not regret, as one cannot fit down to any thing, that requires much application, but with extreme reluctance; for such is the debilitating quality of our violent heats at this season, that an inexpressible languor enervates every faculty, and renders even the thought of exercising them painful.

'Tis now about three o' clock; the sun bears nearly S. W. and I am writing in a piazza, open at each end, on the north-east side of my house, perfectly in the shade: a small breeze at S. E. blows freely thro' it; no buildings are nearer, to reflect the heat, than 60 yards: yet in a thermometer hanging by me, made by Mr. Bird, and compared by the late Mr. George Graham with an approved one of his own, the mercury stands at 102. Twice it has risen this summer to the same height; viz. on the 28th of June, and the 11th of July. Several times it has been at 100, and for many days successively at 98;  
and

and did not in the nights sink below 89. I think it highly probable, that the inhabitants of this town breathe a hotter air than any other people on the face of the earth. The greatest heat we had last year was but 92, and that but once: from 84 to 90 were the usual variations; but this is reckoned an extraordinary hot summer. The weather-wise of this country say it forebodes a hurricane; for it has always been remarked, that these tempests have been preceded by continual and uncommon heats. I must acquaint you, however, that the heats we are subject to here are more intense than in any other parts of the province, the town of Savannah being situated upon a sandy eminence, and sheltered all round with high woods. But it is very sufficient, that the people actually breathe so hot an air as I describe; and no less remarkable, that this very spot, from its height and dryness, is reckoned equally healthy with any other in the province.

I have frequently walked an hundred yards under an umbrella, with a thermometer suspended from it by a thread to the height of my nostrils, when the mercury has rose to 105; which is prodigious. At the same time I have confined this instrument close to the hottest part of my body, and have been astonished to observe, that it has subsided several degrees. Indeed, I never could raise the mercury above 97 with the heat of my body.

You know, dear Sir, that I have traversed a great part of this globe, not without giving some attention to the peculiarities of each climate; and I can fairly pronounce, that I never felt such heats any-where as in Georgia. I know experiments on this subject are

extremely liable to error ; but I presume I cannot now be mistaken, either in the goodness of the instrument, or in the fairness of the trials, which I have repeatedly made with it. This same thermometer I have had thrice in the equatorial parts of Africa ; as often at Jamaica, and the West India islands ; and, upon examination of my journals, I do not find, that the quicksilver ever rose in those parts above the 87th degree, and to that but seldom : its general station was between the 79th and 86th degree ; and yet I think I have felt those degrees, with a moist air, more disagreeable than what I now feel.

In my relation of the late expedition to the north-west, if I recollect right, I have observed, that all the changes and variety of weather, that happen in the temperate zone throughout the year, may be experienced at the Hudson's Bay settlements in 24 hours. But I may now extend this observation ; for in my cellar the thermometer stands at 81, in the next story at 102, and in the upper one at 105 ; and yet these heats, violent as they are, would be tolerable, but for the sudden changes that succeed them. On the 10th of December last the mercury was at 85 ; on the 11th it was so low as 38 of the same instrument. What havoc must this make with an European constitution ? Nevertheless, but few people die here out of the ordinary course ; tho' indeed one can scarce call it living, merely to breathe, and trail about a vigorless body ; yet such is generally our condition from the middle of June to the middle of September. Dear Sir,

Yours most affectionately,

Henry Ellis.

CIII.

CIII. *The Invention of a General Method for determining the Sum of every 2d, 3d, 4th, or 5th, &c. Term of a Series, taken in order; the Sum of the whole Series being known.* By Thomas Simpson, F. R. S.

Read Nov. 16,  
1758.

**A**S the doctrine of Series' is of very great use in the higher branches of the mathematics, and their application to nature, every attempt tending to extend that doctrine may justly merit some degree of regard. The subject of the paper, which I have now the honour to lay before the Society, will be found an improvement of some consequence in that part of science. And how far the business of finding fluents may, in some cases, be facilitated thereby, will appear from the examples subjoined, in illustration of the general method here delivered.

The series propounded, whose sum ( $S$ ) is supposed to be given (either in algebraic terms, or by the measures of angles and ratio's, &c.) I shall here represent by  $a + bx + cx^2 + dx^3 + ex^4$ , &c. and shall first give the solution of that case, where every third term is required to be taken, or where the series to be summed is  $a + dx^3 + gx^6 + kx^9$ , &c. By means whereof, the general method of proceeding, and the resolution of every other case, will appear evident.

Here, then, every *third* term being required to be taken, let the series ( $a + dx^3 + gx^6$ , &c.), whose  
value

value is sought, be conceived to be composed of *three* others.

$$\frac{1}{2} \times a + b \times \overline{px} + c \times \overline{px^2} + d \times \overline{px^3} + e \times \overline{px^4}, \&c.$$

$$\frac{1}{2} \times a + b \times \overline{qx} + c \times \overline{qx^2} + d \times \overline{qx^3} + e \times \overline{qx^4}, \&c.$$

$$\frac{1}{2} \times a + b \times \overline{rx} + c \times \overline{rx^2} + d \times \overline{rx^3} + e \times \overline{rx^4}, \&c.$$

having all the *same form*, and the *same coefficients* with the series first proposed, and wherein the converging quantities  $px$ ,  $qx$ ,  $rx$ , are also in a determinate (tho' yet unknown) ratio to the original converging quantity  $x$ . Now, in order to determine the quantities of these ratios, or the values of  $p$ ,  $q$ , and  $r$ , let the terms containing the same powers of  $x$ , in the two equal values, be equated in the common way:

So shall,

$$\frac{1}{2} b \times px + \frac{1}{2} b \times qx + \frac{1}{2} b \times rx = 0$$

$$\frac{1}{2} c \times p^2 x^2 + \frac{1}{2} c \times q^2 x^2 + \frac{1}{2} c \times r^2 x^2 = 0$$

$$\frac{1}{2} d \times p^3 x^3 + \frac{1}{2} d \times q^3 x^3 + \frac{1}{2} d \times r^3 x^3 = d x^3$$

$$\frac{1}{2} e \times p^4 x^4 + \frac{1}{2} e \times q^4 x^4 + \frac{1}{2} e \times r^4 x^4 = 0$$

&c.

And consequently,

$$p + q + r = 0$$

$$p^2 + q^2 + r^2 = 0$$

$$p^3 + q^3 + r^3 = 3$$

$$p^4 + q^4 + r^4 = 0, \&c.$$

Make, now,  $p^3 = 1$ ,  $q^3 = 1$ , and  $r^3 = 1$ ; that is, let  $p$ ,  $q$ , and  $r$ , be the three roots of the cubic equation  $x^3 = 1$ , or  $x^3 - 1 = 0$ : then, seeing both the second and third terms of this equation are wanting,

not

not only the sum of all the roots ( $p + q + r$ ) but the sum of all their squares ( $p^2 + q^2 + r^2$ ) will vanish, or be equal to nothing (by common algebra), as they ought, to fulfil the conditions of the two first equations. Moreover, since  $p^3 = 1$ ,  $q^3 = 1$ , and  $r^3 = 1$ , it is also evident, that  $p^4 + q^4 + r^4 (= p + q + r) = 0$ ,  $p^5 + q^5 + r^5 (= p^2 + q^2 + r^2) = 0$ ,  $p^6 + q^6 + r^6 (= p^3 + q^3 + r^3) = 3$ . Which equations being, in effect, nothing more than the first three repeated, the values of  $p, q, r$ , above assigned, equally fulfil the conditions of these also: so that the series arising from the addition of three assumed ones will agree, in every term, with *that* whose sum is required: but those series' (whereof the quantity in question is composed) having all of them the *same form* and the *same coefficients* with the original series  $a + bx + cx^2 + dx^3$ , &c. ( $= S$ ), their sums will therefore be truly obtained, by substituting  $px, qx$ , and  $rx$ , successively, for  $x$ , in the given value of  $S$ . And, by the very same reasoning, and the process above laid down, it is evident, that, if every  $n^{\text{th}}$  term (instead of every third term) of the given series be taken, the values of  $p, q, r, s$ , &c. will then be the roots of the equation  $x^n - 1 = 0$  \*; and that, the

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\* If  $\alpha, \beta, \gamma, \delta$ , &c. be supposed to represent the co-sines of the angles  $\frac{360^\circ}{n}$ ,  $2 \times \frac{360^\circ}{n}$ ,  $3 \times \frac{360^\circ}{n}$ , &c. (the radius being unity); then the roots of the equation  $x^n - 1 = 0$  (expressing the several values of  $p, q, r, s$ , &c.) will be truly defined by  $1, \alpha + \sqrt{\alpha\alpha - 1}, \alpha - \sqrt{\alpha\alpha - 1}, \beta + \sqrt{\beta\beta - 1}, \beta - \sqrt{\beta\beta - 1}$ , &c. The demonstration of this will be given farther on.



sum of all the terms so taken, will be truly obtained by substituting  $px, qx, rx, sx, \&c.$  successively for  $x$ , in the given value of  $S$ , and then dividing the sum of all the quantities thence arising by the given number  $n$ .

The same method of solution holds equally, when, in taking every  $n^{\text{th}}$  term of the series, the operation begins at some term after the first. For all the terms preceding *that* may be transposed, and the whole equation divided by the power of  $x$  in the first of the remaining terms; and then the sum of every  $n^{\text{th}}$  term (beginning at the first) will be found by the preceding directions; which sum, multiplied by the power of  $x$  that before divided, will evidently give the true value required to be determined. Thus, for example, let it be required to find the sum of every third term of the given series  $a + bx + cx^2 + dx^3 + ex^4, \&c. (= S)$ , beginning with  $cx^2$ . Then, by transposing the two first terms, and dividing the whole by  $x^2$ , we shall have  $c + dx + ex^2 + fx^3, \&c. = \frac{S - a - bx}{x^2} (= S')$ . From whence having found the sum of every third term of the series  $c + dx + ex^2 + fx^3, \&c.$  beginning at the first ( $c$ ), that sum, multiplied by  $x^2$ , will manifestly give the true value sought in the present case.

And here it may be worth while to observe, that all the terms preceding *that* at which the operation (in any case) begins, may (provided they exceed not in number the given interval  $n$ ) be intirely disregarded,

regarded, as having no effect at all in the result. For if in that part  $\left(\frac{-a - bx}{xx}\right)$  of the value of  $S'$ , above exhibited, in which the first terms,  $a$  and  $bx$ , enter, there be substituted  $px, qx, rx$ , successively, for  $x$  (according to the *prescript*) the sum of the quantities thence arising will be

$$\begin{aligned} & -\frac{a}{p^2 x^2} - \frac{a}{q^2 x^2} - \frac{a}{r^2 x^2} \\ & -\frac{b}{p x} - \frac{b}{q x} - \frac{b}{r x} \end{aligned}$$

which, because  $p^3 = 1, q^3 = 1, \&c.$  (or  $p^2 = p, q^2 = \frac{1}{q}, \&c.$ ) may be expressed thus ;

$$\begin{aligned} & -\frac{a}{xx} \times p + q + r \\ & -\frac{b}{x} \times \overline{p^2 + q^2 + r^2} \end{aligned}$$

But, that  $p + q + r = 0$ , and  $p^2 + q^2 + r^2 = 0$ , hath been already shewn ; whence the truth of the general observation is manifest. Hence it also appears, that the method of solution above delivered, is not only general, but includes this singular beauty and advantage, that in all series' whatever, whereof the terms are to be taken according to the same assigned order, the quantities ( $p, q, r, \&c.$ ), whereby the resolution is performed, will remain invariably the same. The greater part of these quantities are indeed *imaginary* ones ; and so likewise will the quantities be that result from them, when substitution is made in the given expression for the value of  $S$ . But by adding, as is usual in like cases, every two corresponding va-

lues, so resulting together, all marks of *impossibility* will disappear.

If, in the series to be summed, the alternate terms (*viz.* the 2d, 4th, 6th, &c.) should be required to be taken under signs contrary to what they have in the original series given; the reasoning and result will be no-ways different; only, instead of making  $p^3 + q^3 + r^3$  (or  $p^n + q^n + r^n$ , &c.)  $= + 3$  (or  $+ n$ ), the same quantity must, here, be made  $= - 3$  (or  $- n$ ). From whence,  $p^n$  being  $= - 1$ ,  $q^n = - 1$ , &c. the values of  $p$ ,  $q$ ,  $r$ , &c. will, in this case, be the roots of the equation  $x^n + 1 = 0$ .

It may be proper, now, to put down an example, or two, of the use and application of the general conclusions above derived. First, then, supposing

the series, whose sum is given, to be  $x + \frac{x^2}{2} + \frac{x^3}{3} + \frac{x^4}{4} \dots + \frac{x^m}{m} + \frac{x^{m+1}}{m+1} + \frac{x^{m+2}}{m+2} \dots$

$+ \frac{x^{m+n}}{m+n} + \frac{x^{m+n+1}}{m+n+1} +$ , &c.  $= - \text{H. Log.}$

$\overline{1-x} (=S)$ ; let it be required, from hence, to

find the sum of the series  $\left( \frac{x^m}{m} + \frac{x^{m+n}}{m+n} + \frac{x^{m+2n}}{m+2n} \right.$

&c.) arising by taking every  $n^{\text{th}}$  term thereof, beginning with that whose exponent ( $m$ ) is any integer

less than  $n$ . Here, the terms preceding  $\frac{x^m}{m}$  being

transposed, and the whole equation divided by  $x^m$ ,

we

we shall have  $\frac{1}{m} + \frac{x}{m+1} + \frac{x^2}{m+2} + \frac{x^3}{m+3}, \&c.$

$= -\frac{1}{x^m} \times \text{H. Log. } \frac{1}{1-x} - \frac{x + \frac{1}{2}x^2, \&c.}{x^m}.$  In

which value, let  $px, qx, rx, \&c.$  be, successively, substituted for  $x$  (according to prescript) neglecting intirely the terms  $\frac{x + \frac{1}{2}x^2}{x^m}$ , as having no effect at all

in the result: from whence we get  $-\frac{1}{px^m} \times \text{Log.}$

$\frac{1}{qx^m} \times \text{Log. } \frac{1}{1-qx} - \frac{1}{rx^m} \times \text{Log.}$

$\frac{1}{rx}, \&c.$  Which multiplied by  $x^m$  (the quantity that before divided) gives  $-\frac{1}{p^m} \times \text{Log. } \frac{1}{1-px} -$

$\frac{1}{q^m} \times \text{Log. } \frac{1}{1-qx} - \frac{1}{r^m} \times \text{Log. } \frac{1}{1-rx}, \&c. =$

$n$  times the quantity required to be determined.

But now, to get rid of the imaginary quantities  $q, r, \&c.$  by means of their known values  $\alpha + \sqrt{\alpha\alpha-1}, \alpha - \sqrt{\alpha\alpha-1}, \&c.$  it will be necessary to observe, that, as the product of any two corresponding ones  $(\alpha + \sqrt{\alpha\alpha-1} \times \alpha - \sqrt{\alpha\alpha-1})$  is equal to unity, we may therefore write  $\alpha - \sqrt{\alpha\alpha-1}^m (= r^m)$  instead of its equal  $\frac{1}{q^m}$ , and  $\alpha + \sqrt{\alpha\alpha-1}^m (= q^m)$

instead of its equal  $\frac{1}{r^m}$ : by which means the two

terms, wherein these two quantities enter, will stand thus;  $-\alpha - \sqrt{\alpha\alpha - 1}^n \times \text{Log. } 1 - qx$   
 $-\alpha + \sqrt{\alpha\alpha - 1}^m \times \text{Log. } 1 - rx$ .

But, if  $A$  be assumed to express the co-sine of an arch ( $\mathcal{Q}$ ),  $m$  times as great as that  $\left(\frac{360^\circ}{n}\right)$  whose co-sine is here denoted by  $\alpha$ ; then will  $A - \sqrt{AA - 1} = * \alpha - \sqrt{\alpha\alpha - 1}^n$ , and  $A + \sqrt{AA - 1} =$

\* Because  $\frac{-x'}{\sqrt{1-xx}}$  and  $\frac{-X'}{\sqrt{1-XX}}$  are known to express the fluxions of the circular arcs whose co-sines are  $x$  and  $X$ , it is evident, if those arcs be supposed in any constant ratio of 1 to  $n$ , that  $\frac{nx'}{\sqrt{1-xx}} = \frac{X'}{\sqrt{1-XX}}$ , and consequently that  $\frac{nx'}{\sqrt{xx-1}} = \frac{X'}{\sqrt{XX-1}}$  ( $= \frac{nx'}{\sqrt{-1} \times \sqrt{1-xx}} = \frac{X'}{\sqrt{-1} \times \sqrt{1-XX}} = \frac{X'}{\sqrt{XX-1}}$ ).

From whence, by taking the fluents,  $n \times \text{Log. } x + \sqrt{xx-1}^n$  (or  $\text{Log. } x + \sqrt{xx-1}^n$ ) =  $\text{Log. } X + \sqrt{XX-1}$ ; and consequently  $x + \sqrt{xx-1}^n = X + \sqrt{XX-1}$ : whence also, seeing  $x - \sqrt{xx-1}$  is the reciprocal of  $x + \sqrt{xx-1}$ , and  $X - \sqrt{XX-1}$  of  $X + \sqrt{XX-1}$ , it is likewise evident, that  $x - \sqrt{xx-1}^n = X - \sqrt{XX-1}$ . Hence, not only the truth of the above assumption, but what has been advanced in relation to the roots of the equation  $z^n - 1 = 0$ , will appear manifest. For if  $x \pm \sqrt{xx-1}$  be put =  $z$ , then will  $z^n (= x \pm \sqrt{xx-1}^n) = X \pm \sqrt{XX-1}$ : where, assuming  $X = 1 = \text{co-f. } 0 = \text{co-f. } 360^\circ = \text{co-f. } 2 \times 360^\circ = \text{co-f. } 3 \times 360^\circ$ , &c. the equation will become  $z^n = 1$ , or  $z^n - 1 = 0$ ; and the different values of  $x$ , in the expression  $(x \pm \sqrt{xx-1})$  for the root  $z$ , will consequently be the co-sines of the arcs,  $\frac{0}{n}$ ,  $\frac{360^\circ}{n}$ ,  $\frac{2 \times 360^\circ}{n}$ , &c. these arcs being

the

$\alpha + \sqrt{\alpha\alpha - 1}$ : which values being substituted above, we thence get

$$-A \times \log. \sqrt{1 - qx} + \log. \sqrt{1 - rx}$$

$$+ \sqrt{AA - 1} \times \log. \sqrt{1 - qx} - \log. \sqrt{1 - rx};$$

whereof the former part (which, exclusive of the factor  $A$ , I shall hereafter denote by  $M$ ) is manifestly

equal to  $-A \times \log. \sqrt{1 - qx} \times \sqrt{1 - rx}$  (by the nature of logarithms)  $= -A \times \log. \sqrt{1 - q + rx + qrx^2}$  (by substituting

the values of  $q$  and  $r$ ): which is now intirely free from imaginary quantities. But, in order to exterminate them out of the latter part also, put  $y =$

$$\log. \sqrt{1 - qx} - \log. \sqrt{1 - rx}; \text{ then will } y = \frac{-qx}{1 - qx}$$

$$+ \frac{rx}{1 - rx} = -\frac{q - r \times x}{1 - q + r \times x + xx} = -\frac{2\sqrt{\alpha\alpha - 1} \times x}{1 - 2\alpha x + xx}$$

$$= -\frac{2\sqrt{-1} \times \sqrt{1 - \alpha} \times x}{2\alpha x + xx}; \text{ where } \frac{\sqrt{1 - \alpha} \times x}{1 - 2\alpha x + xx} \text{ ex-}$$

presseth the fluxion of a circular arch ( $N$ ) whose radius

is 1, and sine  $= \frac{\sqrt{1 - 2\alpha} \times x}{1 - 2\alpha x + xx}$ ; consequently  $y$  will be

$= -2\sqrt{-1} \times N$ : which, multiplied by  $\sqrt{AA - 1}$ , or its equal  $\sqrt{-1} \times \sqrt{1 - AA}$ , gives  $2\sqrt{1 - AA} \times N$ ;

the corresponding *submultiples* of those above, answering to the cosine  $X (= 1)$ . — In the same manner, if  $X$  be taken  $= -r = \text{co-f. } 180^\circ = \text{co-f. } 3 \times 180^\circ = \text{co-f. } 5 \times 180^\circ$ , &c. then will  $z'' = -r$ , or  $z'' + 1 = 0$ ; and the values of  $x$  will, in this case, be the co-sines of  $\frac{180^\circ}{n}$ ,  $3 \times \frac{180^\circ}{n}$ ,  $5 \times \frac{180^\circ}{n}$ , &c.

and,

and, this value being added to that of the former part (found above), and the whole being divided by  $n$ , we thence obtain  $\frac{-AM + 2\sqrt{1-AA} \times N}{n}$ , or  $\frac{1}{n}$

$\times \frac{-\text{co-f. } \mathcal{Q} \times M + \text{fin. } \mathcal{Q} \times 2N}{n}$  for that part of the value sought depending on the two terms affected with  $q$  and  $r$ . From whence the sum of any other two corresponding terms will be had, by barely substituting one letter, or value, for another: So that,

$$\begin{aligned} & -\log. \sqrt{1-x} \\ & -\text{co-f. } \mathcal{Q} \times M + \text{fin. } \mathcal{Q} \times 2N \\ \frac{1}{n} \times \{ & -\text{co-f. } \mathcal{Q}' \times M' + \text{fin. } \mathcal{Q}' \times 2N' \\ & -\text{co-f. } \mathcal{Q}'' \times M'' + \text{fin. } \mathcal{Q}'' \times 2N'' \\ & + \&c. \quad \quad + \&c. \end{aligned}$$

will truly express the sum of the series proposed to be determined;  $M, M', M'' \&c.$  being the hyperbolic logarithms of  $1 - 2\alpha x + xx$ ,  $1 - 2\beta x + xx$ ,  $1 - 2\gamma x + xx$ ,  $\&c.$   $N, N', N'' \&c.$  the arcs

whose sines are  $\frac{x\sqrt{1-\alpha\alpha}}{\sqrt{1-2\alpha x+xx}}$ ,  $\frac{x\sqrt{1-\beta\beta}}{\sqrt{1-2\beta x+xx}}$ ,  $\frac{x\sqrt{1-\gamma\gamma}}{\sqrt{1-2\gamma x+xx}}$ ,  $\&c.$  and  $\mathcal{Q}, \mathcal{Q}', \mathcal{Q}'' \&c.$  the mea-

sures of the angles expressed by  $\frac{360^\circ}{n} \times m$ ,  $2 \times \frac{360^\circ}{n} \times m$ ,  $3 \times \frac{360^\circ}{n} \times m$ ,  $\&c.$  And here it may not be amiss to take

notice, that the series  $\frac{x^m}{m} + \frac{x^{m+n}}{m+n} + \frac{x^{m+2n}}{m+2n} + \&c.$  thus determined, is that expressing the fluent of  $\frac{x^{m-1}x}{1-x^n}$ ; corresponding to one of the two famous

*Cotefian forms.* From whence, and the reasoning above laid down, the fluent of the other form,

$\frac{x^{m-1} \dot{x}}{1+x^n}$ , may be very readily deduced. For, since

the series  $\left( \frac{x^m}{m} - \frac{x^{m+n}}{m+n} + \frac{x^{m+2n}}{m+2n} - \frac{x^{m+3n}}{m+3n} \right.$

&c.) for this last fluent, is that which arises by

changing the signs of the alternate terms of the

former; the quantities  $p, q, r$ , &c. will here (agreeably to a preceding observation) be the roots of the

equation  $x^n + 1 = 0$ ; and, consequently,  $\alpha, \beta, \gamma, \delta$ , &c.

the co-sines of the arcs  $\frac{180^\circ}{n}, 3 \times \frac{180^\circ}{n}, 5 \times \frac{180^\circ}{n}$ , &c.

(as appears by the foregoing note). So that, making

$\mathcal{Q}, \mathcal{Q}', \mathcal{Q}'',$  &c. equal, here, to the measures of the

angles  $\frac{180^\circ}{n} \times m, 3 \times \frac{180^\circ}{n} \times m, 5 \times \frac{180^\circ}{n} \times m$ , &c. the

fluent sought will be expressed in the very same man-

ner as in the preceding case; except that the first

term,  $-\log. \frac{1}{1-x}$  (arising from the *rational* root  $p=1$ ) will here have no place.

After the same manner, with a small increase of

trouble, the fluent of  $\frac{x^{m-1} \dot{x}}{1 \pm 2/x^n + x^{2n}}$  may be derived,

$m$  and  $n$  being any integers whatever. But I shall

now put down one example, wherein the impossible

quantities become exponents of the powers, in the

terms where they are concerned.

The series here given is  $1 - x + \frac{x^2}{2} - \frac{x^3}{2.3} + \frac{x^4}{2.3.4} - \frac{x^5}{2.3.4.5}$ , &c. = the number whose hyp. log.



is  $-\alpha$ , and it is required to find the sum of every  $n^{\text{th}}$  term thereof, beginning at the first. Here the quantity sought will (according to the general rule) be truly defined by the  $n^{\text{th}}$  part of the sum of all the numbers whose respective logarithms are  $-p\alpha$ ,  $-q\alpha$ ,  $-r\alpha$ , &c.; which numbers, if  $N$  be taken to denote the number whose hyp. log. = 1, will be truly expressed by  $N^{-p\alpha}$ ,  $N^{-q\alpha}$ ,  $N^{-r\alpha}$ , &c. From whence, by writing for  $p, q, r$ , &c. their equals 1,  $\alpha + \sqrt{\alpha\alpha - 1}$ ,  $\alpha - \sqrt{\alpha\alpha - 1}$ ,  $\beta + \sqrt{\beta\beta - 1}$ ,  $\beta - \sqrt{\beta\beta - 1}$ , &c. and putting  $\alpha' = \sqrt{1 - \alpha\alpha}$ ,  $\beta' = \sqrt{1 - \beta\beta}$ , &c. we shall have  $\frac{1}{n} \times N^{-p\alpha} + N^{-q\alpha} + N^{-r\alpha}$ , &c. =  $\frac{1}{n}$  into  $N^{-\alpha} + N^{-\alpha\alpha} \times N^{-\alpha x \sqrt{-1}} + N^{\alpha x \sqrt{-1}} + N^{-\beta\alpha} \times N^{-\beta' x \sqrt{-1}} + N^{\beta' x \sqrt{-1}} + \text{\&c.}$  But  $N^{-\alpha x \sqrt{-1}} + N^{\alpha x \sqrt{-1}}$  is known to express the double of the co-sine of the arch whose measure (to the radius 1) is  $\alpha'x$ . Therefore we have  $\frac{1}{n}$  into  $N^{-\alpha} + N^{-\alpha\alpha} \times 2 \text{ co-f. } \alpha'x + N^{-\beta\alpha} \times 2 \text{ co-f. } \beta'x$ , &c. for the true sum, or value proposed to be determined.

The solution of this case, in a manner a little different, I have given some time since, in another place; where the principles of the general method, here extended and illustrated, are pointed out. I shall put an end to this paper with observing, that if, in the series

series given, the even powers of  $x$ , or any other terms whatever, be wanting, their places must be supplied with cyphers ; which, in order the of numbering off, must be reckoned as real terms.

CIV. *Observatio Eclipsis Lunæ Die 30 Julii 1757. habita Olissipone à Joanne Chevalier, Congregationis Oratorii Presbytero, è Regia Londinenfi Societate. Communicated by Jacob de Castro Sarmiento, M D. F. R. S.*

Tubo optico 8 pedum.

		h	'	"
Read Nov. 16. 1758.	I			
Nitium penumbrae	—	9	15	18
Initium dubium eclipsis	—	9	22	24
Certo jam incœperat	—	9	23	34
Umbra ad mare humorum observata	}	9	31	2
vitro plano cœruleo				
Solo tubo optico observata	—	9	31	29
Vitro flavo observata	—	9	31	48
Umbra tangit Grimaldum observata	}	9	31	20
vitro plano cœruleo				
Solo tubo optico	—	9	31	50
Vitro plano flavo	—	9	32	8
Totus Grimaldus tegitur observatus	}	9	34	4
vitro plano cœruleo				
Solo tubo optico	—	9	34	28
Vitro flavo	—	9	34	47
Vol. 50.	5 F			Umbra

Umbra ad Tychonem observata vitro			11
plano cæruleo — — — }	9	38	25
Solo tubo optico — — —	9	38	42
Vitro flavo — — —	9	38	59
Umbra ad Harpalum vitro cæruleo			
observata — — — }	9	55	6
Solo tubo optico — — —	9	55	35
Umbra ad Fracastorium — — —	9	59	57
Umbra ad Mare Nectaris — — —	10	00	50
Observata vitro flavo — — —	10	1	8
Umbra ad Dionysium — — —	10	5	2
Umbra tangit Mare Tranquillitatis — — —	10	5	50
Umbra ad Mare Serenitatis — — —	10	10	16
Umbra tegit Menelaum observata vi-			
tro cæruleo — — — }	10	11	4
Solo tubo optico — — —	10	11	29
Vitro flavo — — —	10	11	50
Totum Mare Fœcunditatis tegitur — — —	10	18	39
Umbra tangit Mare Crisium vitro cæ-			
ruleo observata — — — }	10	22	52
Solo tubo optico — — —	10	23	12
Vitro flavo — — —	10	23	29
Umbra ad Proclum — — —	10	23	33
Possidonius totus tegitur — — —	10	23	50
Totum Mare Serenitatis tegitur — — —	10	24	36
Totum Mare Crisium ab umbra tegitur — — —	10	30	27
Plato tegitur vitro cæruleo observatus — — —	10	31	26
Solo tubo optico — — —	10	31	48
Vitro flavo — — —	10	32	4
Obscuratio maxima — — —	10	55	40

## EMERSIONES.

	h	7	77
Plato emergit observatus vitro flavo	11	19	5
Solo tubo optico — — —	11	19	31
Vitro cæruleo — — —	11	19	50
Aristarchus emergit — — —	11	21	3
Gassendus incepit emergere observatus vitro flavo — — —	11	25	36
Observatus solo tubo optico — — —	11	25	52
Observatus vitro cæruleo — — —	11	26	11
Gassendus totus extra umbram — — —	11	28	2
Schicardus incipit emergere — — —	11	45	44
Totus extra umbram — — —	11	47	10
Totum Mare Humorum extra umbram	11	46	50
Menelaus extra umbram — — —	11	55	36
Mare Serenitatis extra umbram — — —	11	59	46
Tycho extra umbra observatus vitro flavo	12	00	33
Solo tubo optico — — —	12	00	52
Vitro cæruleo — — —	12	1	14
Incipit emergere Mare Crisium — — —	12	8	31
Totum Mare Crisium extra umbram	12	16	28
Finis eclipsis — — —	12	28	26

Observatio hæc peracta é cœlo claro ; umbra autem terræ ita diluta erat, ut maculæ in ea conditæ satis dignoscerentur.

CV. *Singular Observations upon the Manchenille Apple.* By John Andrew Peyssonnel, M. D. F. R. S. *Translated from the French.*

Read Nov. 16, 1758. **T**HE cruel effects of the tree called Manchenille are known to all the world: its milk, which the savages make use of to poison their arrows, makes the wounds inflicted with them mortal. The rain, which washes the leaves and branches, causes blisters to rise like boiling oil; even the shade of the tree makes those who repose under it to swell; and its fruit is esteemed a deadly poison. I was informed, as a very extraordinary thing, that a breeding woman was so mad as to eat three of them, which did her very little harm; and this was looked upon as a miracle, and a proof of the surprising effects of the imagination and longings of women with child.

But here is a fact, which will scarce be credited by many persons, who have frequented these Islands: which I declare to be true.

One Vincent Banchi, of Turin in Piedmont, a strong robust man, and an old foldier, of about forty-five years of age, belonging to the horse, was a slave with the Turks eleven years, having been taken prisoner at the siege of Belgrade. He was overseer of my habitation towards the month of July of the year 1756. He was one day walking upon the sea side, and seeing a great number of apples upon the ground, was charmed with their beautiful colours, and  
sweet

sweet smell, resembling that of the apple called d'apis: he took and eat of them, without knowing what they were; he found they had a subacid taste; and having eaten a couple of dozen of them, he fill'd his pockets, and came home, eating the rest as he came. The Negroes, that saw him eat this cruel fruit, told him it was mortal; upon which he ceased to eat them, and threw away the rest.

About four in the afternoon, *viz.* an hour after this repast, his belly swelled considerably, and he felt as it were a consuming fire in his bowels. He could not keep himself upright; and at night the swelling of his belly increased, with the burning sensation of his bowels. His lips were ulcerated with the milk of the fruit, and he was seized with cold sweats; but my principal Negro made him a decoction of the leaves of a *Ricinus* \* in water, and made him drink plentifully of it, which brought on a vomiting, followed by a violent purging; both which continued for four hours, during which it was thought he would die. At length these symptoms grew less; and my Negroes made him walk, and stir about by degrees; and soon after they were stopped. Rice-gruel, which they gave him, put an end to all these disorders; and in four-and-twenty hours he had no more ailments nor pain; the swelling of his belly diminished in proportion to his evacuations upwards and downwards, and he has continued his functions without being any more sensible of the poison. We see by this, that the effects of the poison of the Manchinelle are different from those of the fish at Guadaloupe, which I mentioned.

Dec. 2. 1756.

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\* *Avellana purgatrix*; in French, *medicinier*.

CVI. *Abstract of a Letter from Mr. William Arderon, F.R.S. to Mr. Henry Baker, F. R. S. on the giving Magnetism and Polarity to Brass. Communicated by Mr. Baker.*

Dear Sir,

Read Nov. 16,  
1758.

**F**OR some time past I have been making experiments on the magnetism of brass, and amongst many pieces that I have tried, find several that readily attract the needle; but whether they have had this property originally, or have received it by hammering, filing, clipping, or any other such-like cause, I cannot yet determine.

I have a very handsome compass-box made of pure brass, as far as I can judge: the needle being taken out, and placed upon a pin fixed properly in a board, and clear of all other magnetics, the box will attract this needle at half an inch distance; and, if suffered to touch, will draw it full 90 degrees from the north or south points; and I think those parts of the box marked north and south attract the strongest. The cover of the box also attracts the needle nearly as much as the box itself.

As to your supposition, that iron may be mixed with the brass, I do not know; but I have been informed it cannot be, as brass fluxes with a much less degree of heat than iron, and iron naturally swims on fluid brass. Besides, many of the specimens of brass I have tried were new as they came from the mill, where they were wrought into plates, and I presume  
were

were not mixed \*; yet these I have given the magnetic virtue to, when they had it not; and some pieces of brass, which naturally attract the needle, seem to the eye as fine a bright yellow as any other, and are as malleable as any I ever met with.

Pieces of brass without any magnetic power, by properly hammering and giving them the double touch, after Mr. Mitchel's method, I have made attract and repel the needle, as a magnet does, having two regular poles: and I now send you one such piece of brass, which I have thus made magnetical. You will also receive a couple of needles, which I made myself after the late Zachary Williams's method, and a little stand whereon to place them, the better to shew how this magnetic bar attracts and repels the needle when properly applied; for it must be noted, that in making these experiments it is necessary to employ a very good needle, about  $3\frac{1}{2}$  inches long, well and tenderly set, and not covered with glass.

You will observe, when you try this bar, that the same poles repel each other, and the contrary poles attract; which proves this piece of brass to be indued with true magnetic virtue and polarity. However it must be noted, that though the same poles repel each other, yet, like natural magnets, in contact, or nearly so, they attract each other; therefore when you would shew the repelling power of this brass bar, you must not bring it nearer the needle than  $\frac{2}{10}$  of an inch.

Magnetic brass does not attract iron, not even the least particle, so far as I can find: whether this is

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\* This refers to Mr. Baker's having supposed, that old iron and old brass may be mixt sometimes, and melted down together.



owing to the weakness of magnetism in the brass, or to some other cause, I don't pretend to know.

I have tried to infuse magnetic virtue into several pieces of copper, lead and pewter; but all my endeavours have not been able to make them attract the needle at all. Indeed, when I have held a piece of pewter, that I have tried to make magnetical, to the needle, the needle would tremble, but not approach the pewter.

I send you another piece of brass, whose either end attracts either of the poles; this I have infused the magnetic virtue into, and can at any time, so as to attract and repel the needle; but, like steel that is set a low blue, it loseth that polarity in a few hours; which may arise for its being too short for its weight, or from its different temper of hardness or softness.

A third piece I also send you, which with all my endeavours I cannot make attract the needle in the least; and yet I can perceive no difference between the appearance of this piece and that of those which do.

Would some ingenious man pursue these experiments, perhaps we might have needles made of brass to act as strongly as steel ones do, which would have the advantage of being less liable to rust at sea than steel ones are.

But my whole design was to shew, that brass is by no means a proper metal to make compass-boxes of, or to be employed in any instrument where magnetism is concerned. For as it is demonstrable, beyond all contradiction, that some brass is found endued with a power of attracting the magnetic needle; that other pieces are capable of receiving it either by  
accident

accident or design, (let it be from its being mixed with iron, or any other cause whatever) brass must be a very improper metal for compass-boxes, as it may occasion many sad and fatal accidents.

Norwich, Octob. 20th, 1758.

It is well known, that brass has been sometimes found to affect and disturb the magnetic needle; but, to give magnetism and polarity to brass, has not, that I have yet heard, been before attempted. I therefore have taken the liberty to lay the above account before this Royal Society, and have also brought the pieces of brass mentioned therein, which have been thus made magnetical.

London,  
Nov. 15. 1759.

H. Baker.

**CVII.** *An Account of the Sea Polypus, by  
Mr. Henry Baker, F. R. S.*

*To the Right Honourable the EARL of MACCLES-  
FIELD, President of the Royal Society.*

My Lord,

Read Nov. 23, 1758. **I** now return the marine animal your Lordship did me the honour to recommend to my examination; which I find to be a species of one kind of the Sea Polypi, mentioned by naturalists; but I think not very accurately described.

The kinds of Sea Polypi are understood to be,  
VOL. 50. 5 G First,

*First*, The Polypus, particularly so called, the Octopus, Preke, or Pour-control: to which kind our subject belongs.

*Secondly*, The Sepia, or Cuttle-fish.

*Thirdly*, The Loligo, or Calamary. And each of these has its different species and varieties\*. The ancients add the Nautilus; and some sorts of Star-fish might perhaps be not improperly ranged among them.

All of the first kind have eight arms, placed at equal distances round the head; below the arms are two eyes, and the body is short and thick.

The Cuttle-fish, and the Calamary, have each of them ten arms; of which eight are shorter ones, tapering gradually to a point from the head, where they all rise, to their extremities: the other two (frequently called Tentacula) are three or four times as long, perfectly round, slender, and of an equal thickness for above two thirds of their whole length; then spreading into a form nearly like that of the shorter arms. Great numbers of *acetabula*, or suckers, are placed somewhat irregularly on each of the shorter arms, and on the spreading parts of the Tentacula, where some of the suckers are a great deal larger than the rest.

The body of the Cuttle-fish is broad and flat, having within it a broad friable white bone; that of the Calamary is a sort of cartilaginous case holding the intestines, of a roundish oblong shape, furnished with two fins, and having within it a thin transparent elastic substance like Isinglass.

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\* Vide Wilkins's real Character, p. 131. Bellon. aquat. p. 330.



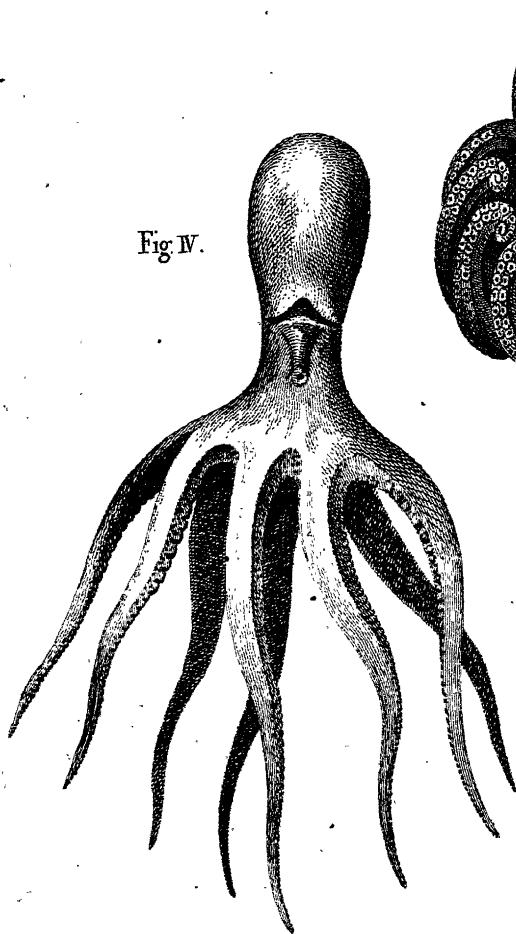


Fig. IV.

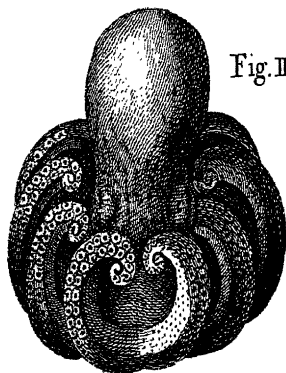


Fig. II.

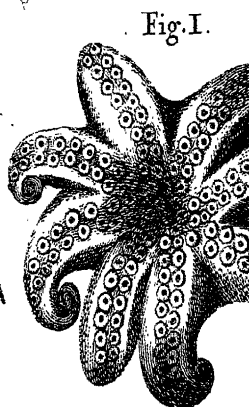
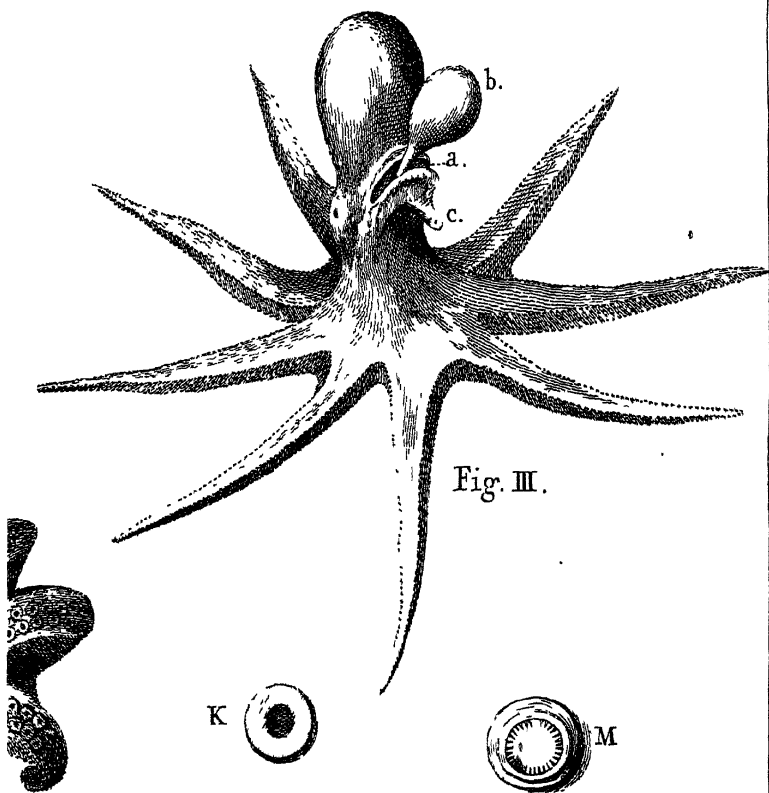


Fig. I.





The mouth of the Pour-control, Cuttle-fish, and Calamary, is placed in the fore-part of the head, between the arms, having an horny beak, hard and hooked like a parrot's, which some writers call the teeth. The eyes of them all are nearly in the same position.

As the subject under examination resembles in some particulars all the above kinds of Polypi, this short account of them may, it is hoped, render the following description of it the more intelligible: and with the same view, Mr. George Edwards, Fellow of the Royal Society, has been so obliging as to make drawings of the animal itself, in four different positions, and of the natural size; which drawings are herewith presented to your Lordship.

Our Polypus is of the Pour-control kind, and I believe of that species called *Bolytæna*; which is said to have a musky smell; but if ours had such a smell, the spirits wherein it lies have taken it quite away.

In the drawing [See TAB. XXIX. *Fig. 1.*] is shewn the anterior part of this animal, which has much the appearance of a Star-fish. Here are eight arms about three inches in length, united at their roots, and placed circularly at equal distances in the same plane, which has a considerable sinking towards the center. These arms diminish from their rise to their extremities, and end exceedingly small. Near the head they are quadrilateral, but the under-side contracting gradually to an edge, they become towards the ends triangular. On the upper side of each arm are two rows of *acetabula*, or suckers, standing in a beautiful order, as close as they can well be placed, and beginning from the center of all the arms. These suckers



are perfectly circular, with edges flat on the top, and a round cavity in the middle of each. They are largest in the widest part of the arm, and lessen as the arm diminishes, till they become so small as hardly to be discernable. It is very difficult to tell their number: I counted as far as fifty in a row, but am certain there are many more; and I don't imagine the eight arms have so few as a thousand on them. They rise some height above the surface of the skin; and wherever they are not, the skin of the arms (unless on the under-side) is granulated like shagreen\*.

As in the other kinds of Polypi the mouth is placed between the arms conspicuously enough, I expected to find it so in this; but the spirits had contracted it so much, that I could discern no opening at all where I thought the mouth must be; and therefore could not say, with assurance, that the mouth was placed there. Under this difficulty I applied to Sir Hans Sloane's most valuable collection of natural history in the British Museum, where I found several species of this kind of Polypi, and amongst the rest a small dried specimen of the same species as ours, and a much larger one in spirits, of a species that comes very near it.

This large specimen afforded the information I stood in need of: for though here also the mouth was closed, and the beak drawn down into the center between the arms, so as not to be seen at all; yet, by the help of Dr. Morton and Mr. Empson, I had the satisfaction to see the mouth opened, and the beak in

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\* Some of the Pour-control kind have but one row of suckers on the arms: such an one I have seen, whose arms were thirty inches long.

the same situation, and of the same form and substance, as in the other kinds of Polypi. Having gained this knowledge, by applying the point of a bodkin, I easily felt the beak in our Polypus; but in so small a subject it cannot be brought to view without dissection, which is the reason it does not appear in these drawings.

*Fig. 2.* represents the Polypus so placed as to shew the situation of the eyes and the form of its body, and also in what manner the arms are turned back in the specimen before us; but we may suppose them thus disposed merely in the act of dying, and that when alive they are moveable in all directions.

On that side of the body opposite to the eyes, and which therefore may be termed the belly-part, there appears a transverse slit or opening in the skin, not in a strait line, but a little semicircular; from the anterior part whereof a tube or pipe proceeds, about one third of an inch in length, smaller at the extremity, where it opens with a round orifice, than at the base, and reaching to within a small distance of the arms. As both the Cuttle-fish and Calamary have a pipe nearly in the same situation, though somewhat different in figure, through which they occasionally discharge an inky liquor, and some writers say the fæces also, it is probable the pipe in this animal may serve to a like purpose; and as the body of the Calamary is included in a case, the slit across the body of this animal shews its belly part to have also a sort of case, though on its back there is no separation as in the Calamary.

Out of the aforesaid slit or opening a bag issues, with a very slender neck, extending towards the tail,  
and

and enlarging gradually to its end. This bag is above half the length of the body, and appears like another body appendant thereto. I should be entirely at a loss concerning this bag, did not some passages in Mr. Turberville Needham's curious observations on the milt vessels of the Calamary enable me to form some conjectures about its use.

Having dissected several Calamaries on the coast of Portugal, without the least indication of milt or roe, and consequently without knowing which were male or female, he was much surprised (about the middle of the month of December) to find a new vessel forming itself in an obvious part, and replete with a milky juice. This was an oval bag, in which the milt vessels formed themselves gradually, the bag unfolding as these framed and disposed themselves in bundles. Before that time he had observed two collateral tubes, which are alike in both sexes; but a regular progress in the expansion of the milt-bag and formation of the milt-vessels had not presented itself before. Those tubes till then appeared open at one extremity, much resembling the female parts of generation in a snail, but did not terminate in a long oval bag extending in a parallel with the stomach more than half the length of the fish, as he found them afterwards when the milt vessels that filled the whole cavity were ripe for ejection. The same ducts without the bag are found in the female also, perhaps for the deposition of the spawn. Vid. *Needham's Microscopical Discoveries*, cap. v.

It appears from this account that the male Calamary (at a certain time of the year only) has a bag wherein the milt-vessels are contained, and that the  
female

female has no such bag. Since therefore the bag of our Polypus is found in the same situation as that of the Calamary, (which is also a kind of Polypus) we may suppose it to be the milt bag, and that our Polypus is a male, taken at a time when the milt was ready for ejection. In the dried specimen at the British Museum, and also in the other specimens, there is the same opening, with the pipe that rises above it towards the arms, but not the least appearance of the bag in question: they are therefore probably females, or if males, were caught before such bag was formed.

*Fig. 3.* presents another view of this Polypus, its arms extended circularly with their under-sides next the eye, and the body so disposed as to shew the transverse opening *a*, the oval bag issuing therefrom *b*, and the pipe rising upwards towards the arms *c*.

*Fig. 4.* shews the Polypus with its transverse opening and the pipe rising therefrom, but without the oval bag; it is figured thus by Rondeletius and Gesner, and the specimen at the British Museum has also this appearance. It is here shewn with the arms extended forwards. *K* is a magnified figure of one of the *acetabula*, or suckers; of which there are two rows on each arm of this Polypus, as before described.

Mr. Needham, in his description of the suckers of the Calamary, (which he had many opportunities of examining whilst alive, and whose mechanism is probably the same as in those of our Polypus) informs us, " that the action of the suckers depends partly  
 " on their shape, which, when they are extended  
 " resembles nearly that of an acorn-cup, and partly  
 " upon a deep circular cartilaginous ring, armed with  
 " small hooks, which is secured in a thin membrane  
 " something

“ something transparent, by the projection of a ledge  
 “ investing the whole circumference about the middle  
 “ of its depth, and not to be extracted without some  
 “ force. That each sucker is fastened by a tendi-  
 “ nous stem to the arm of the animal: which stem,  
 “ together with part of the membrane that is below  
 “ the circumference of the cartilaginous ring, rises  
 “ into and fills the whole cavity when the animal  
 “ contracts the sucker for action. In this state  
 “ whatever touches it is first held by the minute  
 “ hooks, and then drawn up to a closer adhesion by  
 “ the retraction of the stem and inferior part of the  
 “ membrane, much in the same manner as a sucker  
 “ of wet leather sustains the weight of a small stone.”  
 Vid. *Microscopical Discoveries*, p. 22.

M shews one of the cartilaginous rings armed with small hooks, of its real size. The ring this is drawn from was taken out of a large sucker of a larger Polypus, and is presented herewith.

By these suckers the Polypus can fix itself to rocks, and prevent its being tossed about in storms and tempests; but their principal use must undoubtedly be to seize and hold its prey: and to this purpose they are most admirably adapted; for when they are all applied and act together, unless the Polypus pleases to withdraw them, nothing can get from it whose strength is insufficient to tear off its arms. Something like these suckers is found by the microscope in the minute fresh water Polype, whereby it is able to bind down and manage a worm much larger and seemingly stronger than itself\*. In like manner the

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\* Of this I gave an account some years ago, in my attempt towards a Natural History of the Polype, chap. v.

*Stella arborefcens* (which may alfo be called a Polypus), though it has not fuckers, yet by the hooks along its arms, and the multiplicity of their branchings, which have been counted as far as 80,000, it can, by spreading its arms abroad like a net, fo fetter and entangle the prey they inclofe when they are drawn together, as to render it incapable of exerting its ftrength: for however feeble thefe branches or arms may fingly be, their power united becomes furprifing. And we are affured nature is fo kind to all thefe animals, that if in their ftuggles any of their arms are broken off, after fome time they will grow again; of which a fpecimen at the Britifh Mufeum is an undoubted proof; for a little new arm is there feen fprouting forth in the room of a large one that had been loft.

It is evident from what has been faid, that the Sea Polypus muft be terrible to the inhabitants of the waters, in proportion to its fize (and Pliny mentions one whole arms were thirty feet in length); for the clofe embraces of its arms and the adhefion of its fuckers muft render the efforts of its prey ineffectual either for refiftance or efcape, unlefs it be endued with an extraordinary degree of ftrength.

Sea Polypi are frequent in the Mediterranean: but Mr. Haviland of Bath, to whom we are obliged for this, which is of a different fpecies, thinks it came from the Weft Indies, where it is called a Cat-fifh. That like it in the Britifh Mufeum alfo came from thence.

As the Polypus I have endeavoured to defcribe is much contracted by lying long in fpirits, and diffection would deftroy a fpecimen well worth preferring, I hope to be excufed if this account fhould be

found deficient in several particulars, or chargeable with some mistakes.

Permit me the honour to be,

My LORD,

Your Lordship's

Most humble and obedient Servant,

Strand,  
Nov. 23d, 1758.

H. Baker.

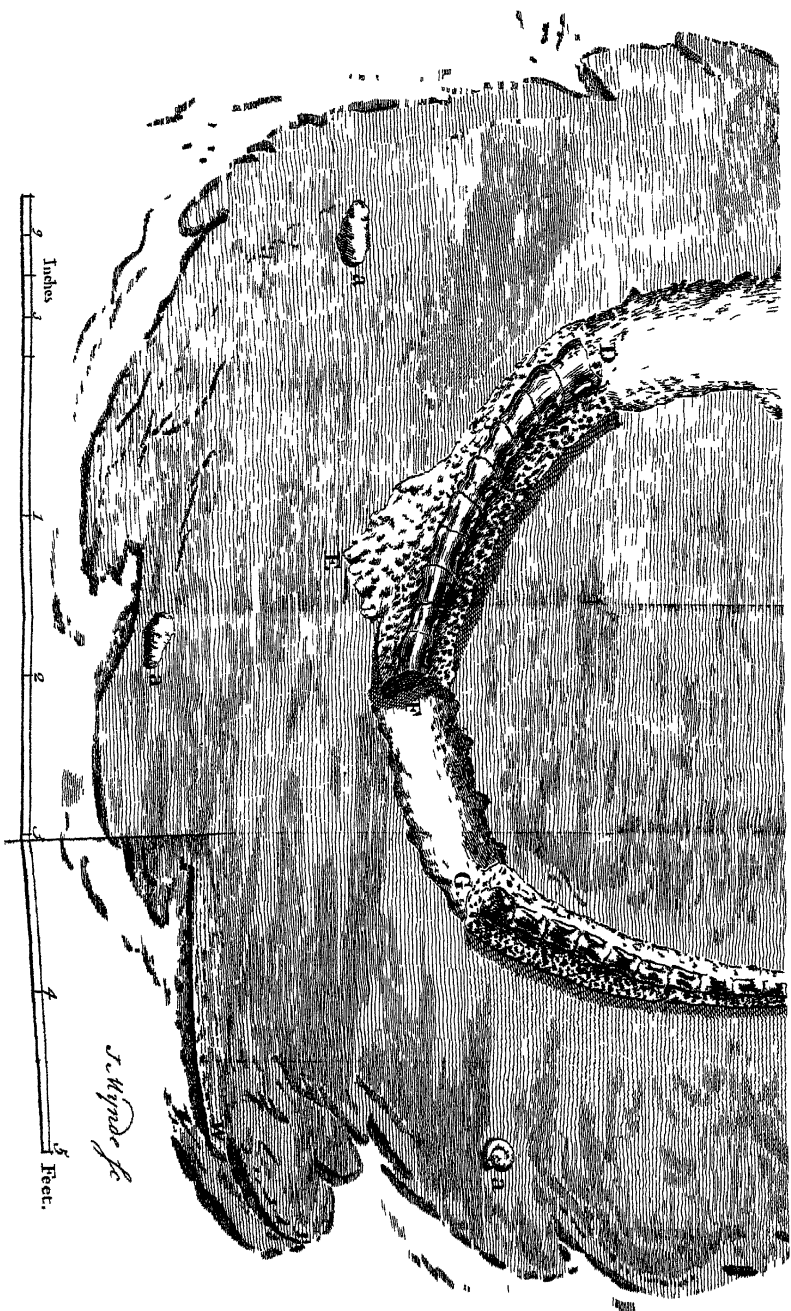
CVIII. *A Description of the fossil Skeleton of an Animal found in the Alum Rock near Whitby. By Mr. Wooller. Communicated by Charles Morton, M. D. F. R. S.*

Read Nov. 23. <sup>1758.</sup> **I**T is in this rock, that the Ammonitæ, or Snake-stones, as they are commonly called, are found, which have undoubtedly been formed in the *exuviae* of fishes of that shape; and though none of that species are now to be met with in the seas thereabouts, yet they in many particulars resemble the Nautilus, which is well known. The internal substance of those stones, upon a section thereof, appears to be a stony concretion, or muddy sparr. Stones of the same matter or substance, in the shape of muscles, cockles, &c. of various sizes, are also found therein, and now and then pieces of wood hardened and crufted over with a stony substance are likewise found in it.

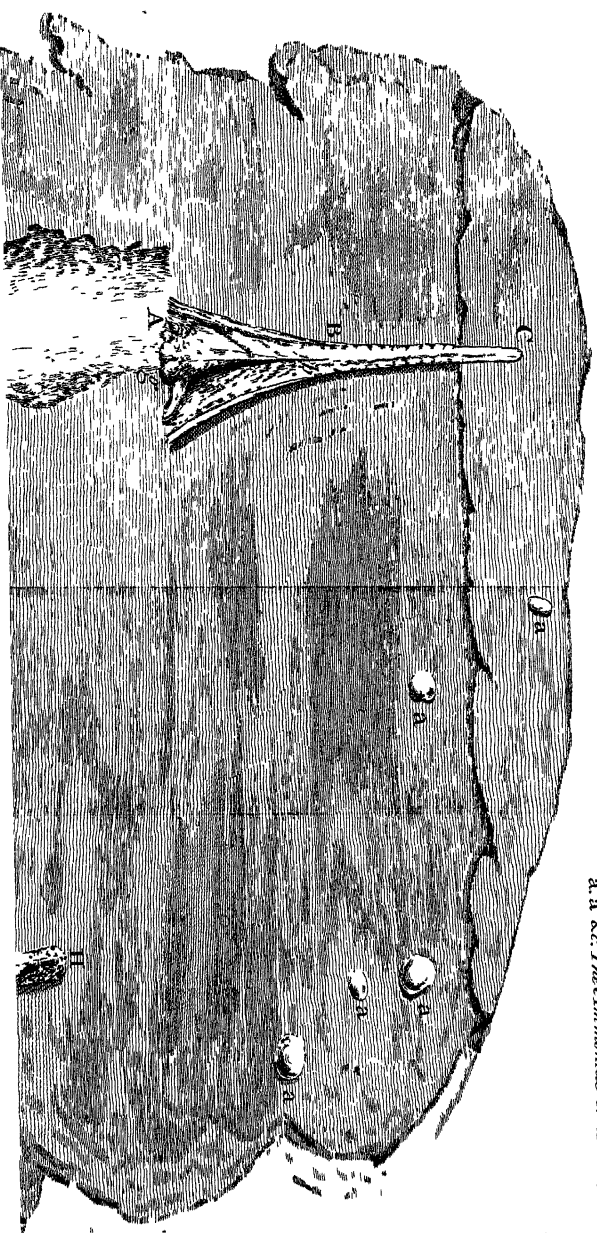
Many naturalists have already observed, that among the vast variety of extraneous substances found at several







*Part of the Fossil Skeleton of an Animal as it appeared on and  
united to the Alton Rock near Whitby, Jan. 3. 1758*



*a. a. &c. The Ammonite or Snake Stones.*



veral depths in the earth, where it is impossible they should have been bred, there are not so many productions of the earth as of the sea; and it appears by the accounts of authors both ancient and modern, that bones, teeth, and sometimes entire skeletons of men and animals, have been dug up or discovered in all ages, and the most remarkable for size commonly the most taken notice of. In the first particular this skeleton will most probably appear to have belonged to an animal of the lizard kind, quadruped and amphibious; and as to its size, much larger than any thing of that kind ever met with or found in this part of the world; though, from the accounts of travellers, something similar is still to be met with in many of the rivers, lakes, &c. of the other three.

When the annexed drawing thereof was taken January 5, 1758. [See TAB. XXX.] there remained no more of the *vertebræ* than is therein expressed; that is, 10 between D and F, and 12 between G and H: but when it was first discovered, about 10 years ago, they were complete; and there was besides the appearance of what was then thought to have been fins, near the back part of the head at A, the same as appeared further backward at E, when this design was made. The *vertebræ*, &c. now wanting having been either dug up by curious persons, or washed away by the violence of the waves at high water, and the accidental beating about of stones, sand, &c. during that time; the water covering this skeleton several feet at high water in spring tides; the cavities in the rock still remaining as in the design.

The substance of the bones, with their *periostium*, on the covered or under side, in most parts remains

intire, and their native colour in some places in a good measure preserved, and the teeth with their smooth polish plainly to be discovered. Part of the mandible near the extremity was covered with a shelf of the rock about three inches thick; which being cut away and removed, both the mandibles appeared under it compleat, with the teeth of the upper and under one, plainly locking or passing by each other. These appeared to be of the *dentes exerti* or fang kind, as well as all the others in the narrow part of the mandible, and further backwards they were not observed. From this ledge or shelf the mandible towards B is single, and appears to be the upper one of the living animal; and from the head not being exactly in the line of the body, that part has been inverted, or quite turned over, and the body itself, as appears from the transverse processes of the *vertebræ*, lies on the right side. There appears one row of teeth only on each side of the mandible, and they are about  $\frac{3}{4}$  of an inch asunder.

The mandible B A, the *cranium g h*, and the *vertebræ* from D to F, were attempted to be taken up whole; but the bones being rendered extremely brittle, and the rock in which they were fixed being a brittle blackish slate, with joints or fissures running in every direction, would not hold together: the whole therefore fell in many pieces, the *vertebræ* in the joints only, which makes them easy to join together again, and besides shows very plainly the transverse and spinal processes thereof, with the foramen in the latter for the spinal marrow. It was now that a piece of the *os femoris*, about four inches long, shewed itself in the sparry concreted substance at E, together with  
a piece

a piece of the *os innominatum*, to which it had been articulated or joined. This, with what has been before remarked, will sufficiently prove this to have been an animal of the quadruped, and probably, from the shape of the cranium peculiar to fishes, of the amphibious kind. At the same time many pieces of the *costæ* or ribs, as broke and crushed up against the *vertebræ*, were plainly visible. The cavities of all the bones were filled with a substance, which appeared the same as the rock itself; and the substance on each side the *vertebræ*, as they laid, was a mixture of sparry concreted matter with that of the rock itself, which is a blackish slate. The animal, when living, must have been at least 12 or 14 feet long. And the dimensions of the whole, or particular parts of the skeleton, may be measured from the scale annexed thereto.

This skeleton lay about six yards from the foot of the cliff, which is about sixty yards in perpendicular height, and must have been covered by it probably not much more than a century ago. The cliff there is composed of various *strata*, beginning from the top, of earth, clay, marble, stones both hard and soft, of various thickneses, and intermixed with each other, till it comes down to the black slate or alum rock, and about 10 or 12 feet deep in this rock, this skeleton laid horizontally, and exactly as designed. The probability, that this cliff has formerly covered this animal, and extended much more into the sea, is not in the least doubted of by those that know it. The various *strata*, of which it is composed, are daily mouldering and falling down; and the bottom, being the slaty alum rock, is also daily beat, washed, and  
wore

wore away, and the upper parts undermined, whence many thousand tuns often tumble down together. Many antient persons now living, whose testimony can be no way doubted of, remember this very cliff extending in some places twenty yards further out than it does at present. In short there is sufficient evidence, that at the beginning it must have extended near a mile further down to the sea than it does at present; and so much the sea has there gained of the land.

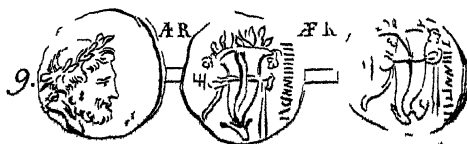
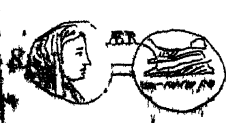
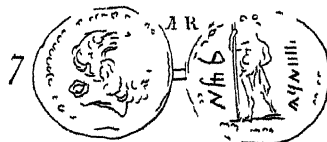
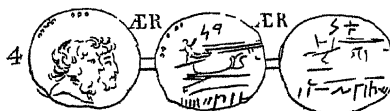
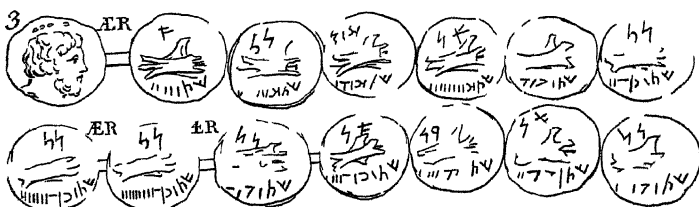
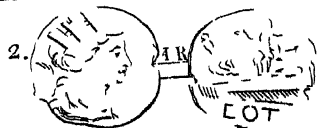
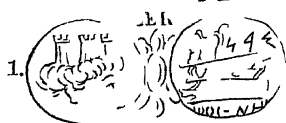
These are the principal facts and circumstances attending the situation and discovery of this skeleton; which from the condition it is in, and from the particular disposition of the *strata* above the place where it is found, seem clearly to establish the opinion, and almost to a demonstration, that the animal itself must have been antediluvian, and that it could not have been buried or brought there any otherwise than by the force of the waters of the universal deluge. The different *strata* above this skeleton never could have been broken through at any time, in order to bury it, to so great a depth as upwards of 180 feet; and consequently it must have been lodged there, if not before, at least at the time when those *strata* were formed, which will not admit of a later date than that above-mentioned.

P. S. In the xlixth vol. page 639, of the *Philosophical Transactions*, an animal is described by Mr. Edwards, which was brought from the Ganges, and resembles this in every respect. He calls it *Lacerta (crocodilus) ventre marsupio donato, faucibus Merganseris rostrum æmulantibus*.





# PHŒNICIAN Coins



CIX. *A Dissertation upon the Phœnician Numeral Characters antiently used at Sidon. In a Letter to the Rev. Thomas Birch, D. D. Secret. R. S. from the Rev. John Swinton, M. A. of Christ-Church, Oxon, F. R. S.*

Reverend Sir,

Read Dec. 7,  
1758.

**H**AVING, by the assistance of the Palmyrene numeral characters, lately made a discovery, which may perhaps hereafter be of considerable service to chronology; I could not longer defer, though now deeply engaged in other matters, communicating it to the Royal Society. Nor will the memoir containing this, I flatter myself, be deemed altogether unworthy the attention of that learned and illustrious body. For, unless I am greatly deceived, it will bid fair to ascertain, with a sufficient degree of precision, the Phœnician dates of several antient Sidonian coins, one of which was struck above a century before the birth of CHRIST, hitherto utterly unknown; and evince the notation of the Phœnicians, at least those of Sidon, when they first appeared, to have been extremely similar to, if not nearly the same with, that of the Palmyrenes.

# I.

A small brass coin of Sidon (1), now in my possession, exhibits on the reverse three Phœnician let-

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(1) See Plate xxxi. Fig. 1.

ters, that form the word SIDON, over the prow of a ship, the usual symbol of the city wherein it was struck. This coin, which is in good conservation, I formerly (2) published and explained. The characters however in the exergue, which I could then make nothing of, were not with sufficient accuracy described. This has induced me to transmit you another draught of the same medal, wherein proper care has been taken to remedy that defect. The two first of those characters, though somewhat imperfect, appear manifestly enough to be *Schin* and *Tzade*; as the former occurs on the Palmyrene (3) marbles, and the latter on several very valuable (4) Phœnician coins. The others so nearly resemble the numeral characters of the Palmyrenes, that they may undoubtedly be considered as pointing out to us a date. Which if we admit, the *Schin* and *Tzade* will seem to be the initial letters of the words שנת צד, THE YEAR OF SIDON, or IN THE YEAR OF SIDON; as the elements *Pe* and *Schin* apparently denote פסח שנת, THE PASCHA OF THE YEAR, or IN THE BEGINNING OF THE YEAR, on the reverse of the famous Samaritan coin of Bologna, published by Sig. Bianconi (5) not many years since. Nor can the phrase, THE YEAR OF SIDON, or IN THE YEAR OF SIDON, intimating the year

(2) *De Num. quibusd. Sam. et Phœn. &c. Dissert.* p. 56—59. & Tab. II. Oxon. 1750.

(3) *Marm. Palmyren. a Cl. Dawk. edit.* pass.

(4) Vid. Hadr. Reland. *Palæst. Illustrat.* p. 1014. Traject. Batavor. 1714. Erasmi Froel. ad *Annal. Compendiar. Reg. & Rer. Syr.* Tab. VIII. &c. Viennæ, 1754.

(5) *De Antiq. Hebræor. et Græcor. Lit. Libel.* Joan. Baptist. Biancon. p. 31, 32. Bononiæ, 1748.

of the proper æra of that city, be looked upon as repugnant either to the Jewish or Phœnician genius ; a similar expression having been used, both in their writings (6) and on their coins (7), about the time that the Phœnician medal before me was struck, by the Jews. That the first of the numeral characters here stands for TWENTY, we may infer from the correspondent one of the Palmyrenes, to the form of which it is by no means unlike. This will likewise be confirmed by the dates preserved on other Phœnician coins, which will be immediately produced. The next, denoting a lesser number, and not representing FIVE, which we find always expressed by minute right lines on the Sidonian medals, must indubitably occupy the place of TEN. The six following strokes, after what has been just observed, will be acknowledged to add SIX to the foregoing numbers ; so that the inscription in the exergue will no longer remain a mystery, the whole only importing, IN THE YEAR OF SIDON XXXVI.

## II.

I have three other coins of Sidon (8), of almost entirely the same type ; only one of them exhibits a date in Greek numerals, and two bear Phœnician dates. The Greek numerals are ΕΟΤ, CCCLXXV ; and the Phœnician correspond with the numbers CXX, CXXVII, to both of which are prefixed the above-mentioned

(6) 1. Maccab. i. 10.

(7) Hadr. Reland. *De Num. Vet. Hebr.* pass. Trajecti ad Rhenum, 1709.

(8) See Plate xxxi. Fig. 2.

initial letters. We meet with draughts of two similar medals in (9) Arigoni, adorned with characters, expressing the numbers CXXVIII, CXXX. All these coins present to our view a turreted head and a branch of palm, pointing out to us the country to which they belong, and on the reverse the usual symbol of Sidon. The year handed down to us by the Greek date EOT, is the 375th of the æra of Seleucus; and those denoted by the Phœnician numerals answer to the 120th, 127th, 128th, and 130th, of the proper æra of Sidon, as will be hereafter more fully evinced. Hence we may certainly collect, that these pieces were struck at Sidon in the years of CHRIST 11, 18, 19, 21, and 64.

### III.

Three coins of Sidon, different from the former, occur in (10) Sig. Haym, and seven (11) more in my little cabinet, whose type is altogether the same, with Phœnician dates, preceded by the two aforesaid initial letters, upon them. To which we may add five, preserved in the noble (12) cabinet bequeathed to Christ-Church, Oxon. by Archbishop Wake, and another in the valuable collection of the Rev. Dr. Barton (13), Canon of the said collegiate church, and a worthy member of this Society. On one side

(9) Honor. Arigon. *Num. Phœnic.* Tab. I. Num. 3, 6. Tarvisii, 1745.

(10) Nicol. Haym Roman. *Del Tesor. Britan.* Vol. i. p. 106. In Londra, 1719.

(11) See Plate xxxi. Fig. 3.

(12) See Plate xxxi. Fig. 3.

(13) See Plate xxxi. Fig. 3.

these medals all exhibit the head of Jupiter, and on the reverse the prow of a ship, the common symbol of Sidon. Most of them had various Phœnician letters at first imprest on the upper part of the reverse, and one of them (which is pretty remarkable) nearly the same characters there that appear in the exergue. The first of the coins mentioned here was struck in the year of Sidon 5. This has been perfectly well preserved, and is more curious than any of the rest; which were emitted from the mint at Sidon in various years of the proper æra of that city, *viz.* the 107th, 108th, 110th, 111th, 112th, 114th, 115th, 116th, 117th, and 119th. We meet on none of these medals with the figure denoting TWENTY, used by the Sidonians, during the period I am now upon. It not a little resembles that which prevailed at Tadmor (14) in the reign of the emperor Claudius, about forty-nine years after the birth of CHRIST. The most antient of the Phœnician coins I am now considering preceded the commencement of the Christian æra 104 years, and is consequently 153 years older than the earliest Palmyrene inscription that has hitherto come to our hands (15).

## IV.

Some years since I published a small brass medal of Sidon (16), with the heads of Jupiter and Juno on one side, and the prow of a ship on the reverse;

(14) See the Phœnician Numerals in Plate xxxii.

(15) *Philosoph. Transact.* Vol. xlviii. Par. ii. p. 726.

(16) *De Num. quibusd. Sam. et Phœn. &c. Dissert.* p. 59—61.  
& Tab. II. Oxon. 1750.

but did not accurately enough describe the numeral characters, and two initial letters, in the exergue. I therefore take the liberty to send (17) you a new draught, perfectly well done, of that inscription. Two more coins of the same type I have since acquired, and another may be seen in (18) Sig. Haym. These four pieces only exhibit the years of Sidon 125 and 132.

## V.

My small collection likewise affords two (19) other Phœnician medals of Sidon, (20) and Archbishop Wake's noble cabinet one, of the same type, with different Phœnician dates in the exergue. To these may be added five, with the publication of which the learned world has been obliged by Sig. Arigoni (21). The anterior faces of these coins are adorned with a veiled head, representing the genius of the city wherein they were struck; and the reverses with a human figure leaning upon a pillar, and holding a branch of palm in its right hand. Several Phœnician letters also there appear, which may perhaps at first sight seem to render it somewhat doubtful, whether the medals belong to Sidon or not. But every suspicion arising from hence must immediately vanish, when we cast our eyes upon the two initial elements, and the numeral characters, in the exergue; which clearly enough indicate the pieces to have been struck

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(17) See Plate xxxi. Fig. 4.

(18) Haym, ubi sup. p. 107.

(19) See Plate xxxi. Fig. 5.

(20) See Plate xxxi. Fig. 5.

(21) Honor. Arigon. *Num. Phœnic.* Tab. I, II. Tarvisii, 1745-  
at

at Sidon, in the 83d, 87th, 95th, 105th, 106th, 108th, 114th, and 116th years of the æra peculiar to that city. A Phœnician coin of Sidon likewise occurs in one (22) of Sig. Arigoni's plates, and another (23) in my collection, with the turrited head and branch of palm visible on three of the (24) medals above described, which indisputably appertain to that city, together with the very Phœnician letters and symbol impressed on the Sidonian coins now before me. This, exclusive of other considerations, that might be offered, must set the point I am here insisting upon beyond dispute.

## VI.

I have another brass Phœnician medal of Sidon (25), not a little resembling those above-mentioned, both in workmanship and size, presenting to our view on one side the head of Jupiter, and on the other a human figure with a lance in its right hand. This coin, which has never yet been published, is adorned with a Phœnician legend on the reverse, different from those of all the others that have hitherto appeared. I therefore judged that a draught of it would not be unacceptable, though the date impressed originally in the exergue (answering to the 26th year of Sidon) has a little suffered from the injuries of time.

## VII.

The next Phœnician medal of Sidon, which I shall take the liberty here to describe, is a small brass

(22) Id. *ibid.* Tab. I. N. 5.

(23) See Plate xxxi. Fig. 6.

(24) See p. 793, 794.

(25) See Plate xxxi. Fig. 7.



one (26), now in my hands, with a veiled head on the anterior face, and the prow of a ship on the reverse. M. Bouterouë (27), who has published it, rightly asserts it to be a Phœnician coin. The year of Sidon, preserved in the exergue of mine, is 74; and that in the exergue of M. Bouterouë's, 73, though the first numeral character of the latter is somewhat deformed.

## VIII.

The last Phœnician medals I shall at present produce, in order to settle the point in view, are (28) two in my possession, intirely agreeing both in type and form, as remarkable as any of the others here touched upon. A similar coin has been published by Sig. Arigoni (29), and another (30) by M. Bouterouë; both of which, on several accounts, merit the attention of the learned. They exhibit on one side the head of Jupiter laureated, with a beard; and on the reverse a double cornucopia, together with three or four Phœnician elements, one or two of which are in a great measure defaced. A brass medal of Sidon occurs in Archbishop Wake's (31) collection, as well as one in (32) mine, with the head of Jupiter done exactly after the same manner as that on the pieces before me, and Europa carried by a bull

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(26) See Plate xxxi. Fig. 8.

(27) *Recherches Curieuses des Monoyes de France &c. Par* Claude Bouterouë, p. 33. A Paris, 1666.

(28) See Plate xxxi. Fig. 9.

(29) Honor. Arigoni, ubi sup. Tab. I. Num. 2.

(30) Claud. Bouterouë, ubi sup. p. 24.

(31) See Plate xxxi. Fig. 9.

(32) See Plate xxxi. Fig. 9.

on the reverse ; which, exclusive of the inscriptions in the exergue, demonstrate the latter to belong to Sidon. The first of mine was struck in the 143d year of the proper æra of that city, and the second five years after. They correct the barbarous date assigned by Sig. Arigoni to his coin. M. Bouterouë has not favoured the learned world with an explication of the medal, of which he has given us a draught. Nor has M. l'Abbé Barthelemy, who likewise mentions this very coin, informed us to what place it appertains ; but contented himself with barely (33) observing, that the letters preserved on the reverse are Phœnician. I flatter myself therefore that I shall not be charged with plagiarism by this celebrated antiquary, in case what is here submitted to the consideration of the Royal Society should be so happy as to meet with the approbation of that learned and illustrious body ; not even by *only* acquainting the public, with a sort of *politesse* so peculiar to his countrymen, that it is now become one of the most distinguishing characteristics of their nation (34), “ that a certain Oxford doctor has done him the honour to *adopt* the explication he had given.”

IX. For

(33) *Mémoires de Litterature, tirés des Registres &c.* Tom. xxiv. p. 64. A Paris, 1756.

(34) The whole note, here referred to, in the original runs thus.  
 “ J’avois lû ce Mémoire à l’Académie en 1749, je le communiquai dans le même temps à un étranger qui se trouvoit alors à Paris, & qui ayant passé tout de suite en Angleterre, fit part à un docteur d’Oxford de l’explication que j’avois donnée de la médaille de Jonathan. Ce dernier *m’a fait l’honneur de l’adopter* dans une savante Dissertation imprimée à Oxford en 1750, à la suite d’une autre Dissertation sur deux inscriptions Phœnicienes.”

## IX.

For the farther illustration of what has been here advanced, it will be requisite to observe, that two æra's were antiently followed at Sidon; the æra of Seleucus, and another peculiar to the inhabitants of that

“ciennes.” *Memoires de Litterature, tirés des Registres de l'Académie Royale des Inscriptions & Belles-Lettres, &c. Tom.xxiv. p. 60. A Paris, 1756.*

For the better understanding of this note, it will be proper to observe, that the stranger therein mentioned was M. Brucker, Professor of History in the University of Basil; with whom I contracted an acquaintance when at Oxford, towards the close of March 1750. This gentleman then informed me, that M. l'Abbé Barthelemy communicated to him draughts of three Samaritan coins of Jonathan, prince and high-priest of the Jews. He added, that one of these exhibited the words ΒΑΣΙΛΕΩΣ ΑΛΕΞΑΝΔΡΟΥ; which, according to him, M. l'Abbé Barthelemy interpreted of Alexander the Great, taking the piece to have been twice struck. This M. Brucker afterwards in a great measure confirmed, by a letter he wrote to me at Oxford; which I published intire in 1750, and endeavoured to prove, that the foregoing inscription was to be understood of Alexander I. king of Syria, and not of Alexander the Great. The Samaritan inscription, which M. Brucker only just touched upon, as is manifest from his letter, I likewise attempted to explain; producing proper vouchers, in support of what I advanced. Thus stands the fact, which seems to have given some offence to M. l'Abbé, stated in the most concise manner possible; and from it, thus stated, as I apprehend, are naturally deducible the following observations.

1. As I differed in opinion from M. l'Abbé, with regard to the words ΒΑΣΙΛΕΩΣ ΑΛΕΞΑΝΔΡΟΥ, as well as in several other respects, and supported by indisputable authorities what I in all points advanced, without receiving from any person whatsoever the least information relative thereto; it very evidently appears, that I did not ~~adopt~~ M. l'Abbé's explication of the coin in question.

2. By publishing M. Brucker's letter, which I ~~have~~ still by me, intire, I both did him justice, and clearly acknowledged M. l'Abbé to have first discovered the medals it treats of to belong to Jonathan,

that city (35). On the Greek brass coins of Sidon, according to F. Frœlich (36), both these epochs seem

than, prince and high-priest of the Jews; and therefore have by no means endeavoured, as he would insinuate, to rob him of the glory of such a discovery.

3. As M. l'Abbé in effect owns himself to have seen my dissertation, and has (if M. Brucker rightly informed me) since the reading of his memoir, substituted my notion, relating to the words, ΒΑΣΙΛΕΩΣ ΑΛΕΞΑΝΔΡΟΥ, in the room of his own; some people may perhaps imagine, that I have at least as much reason to recriminate on this occasion, as he had to charge me with the *adoption* of his explication. Nay, as he expressly acquaints the public, that M. Brucker imparted to me the very interpretation of the coin he (M. l'Abbé) had before communicated to him, and as this interpretation most evidently makes it to have been first struck in the reign of Alexander the Great; every unprejudiced person, unacquainted with the elevated genius and extensive erudition of M. l'Abbé, will be strongly induced to believe, that there would be no great injustice in a recrimination. But far be it from me to retort the accusation upon M. l'Abbé. His uncommon learning, his singular modesty, his strict honour, his utter contempt of vanity and ostentation in every shape, so conspicuous to all the world, must set him infinitely above the reach of such an imputation. However, notwithstanding the superior merit and exalted abilities of M. l'Abbé, notwithstanding the known aversion of the French writers to the practice here hinted at, and their most generous and candid treatment hitherto of those belonging to the British nation, it will perhaps hereafter be thought expedient, by the ACADEMY OF INSCRIPTIONS AND BELLES LETTRES, not frequently to suffer an interval of seven years to elapse, between the reading and publication of their memoirs. For by such unaccountable delays, if often repeated, a handle may possibly be given to many of the *haughty islanders* of reflecting upon, or at least entertaining unfavourable sentiments of, some of the members of that illustrious body.

See *De Num. quibusd. Sam. & Phœn. Sc. Dissert.* p. 61—72. Oxon. 1750.

(35) F. Henric. Nor. Veronens. *An. et Epoch. Syremanâ. Sc.* p. 414—424. Lipsiæ, 1696.

(36) Erafm. Frœl. *Annal. Cœpend. Reg. et Rer. Syr.* p. 113. Viennæ, 1754.

to have been used. However, the supputation pointed out to us by the date on the Greek medal above-mentioned was undoubtedly made according to the æra of Seleucus; since otherwise the year exhibited by that date must have been nearly coincident with the 266th of CHRIST, which by those versed in this kind of literature will never be allowed. For had the piece presented to our view so recent a date, as Sidon first became a Roman colony in the reign of Elagabalus (37), above forty years before; the reverse ought to have been adorned with some other letters intimating this, as were those of the Sidonian (38) coins posterior to that event. As certain is it that all the Phœnician medals of Sidon, whose numeral characters have been interpreted here, acknowledge no other epoch than the proper one of that city, which commenced in the year (39) of Rome 643. This, I flatter myself, from the following considerations, exclusive of others that might, with equal facility, be offered, will even to demonstration appear.

1. The fifth year mentioned by the oldest of these coins cannot be the fifth year of the æra of Seleucus, because the Sidonians were then subject to Antigonus (40), in whose territories the supputation according to that epoch did not take place; and consequently the piece itself must have been struck in the fifth

(37) Joan. Harduin. *Op. Select.* p. 155, 156. Amst. 1709.  
Joan. Foy-Vaillant Bellovac. *Numismat. Ær. Imperator. &c. Par.*  
*Alt.* p. 97. Parisiis, 1695.

(38) *Idem* *ibid.* & *alib.*

(39) F. Henr. Nor. Veronenf. *ubi sup.*

(40) Died. Sic. lib. xix. Plutarch. in *Demetr.* Appian. in *Syriac.*

year of the proper æra of Sidon, nearly coincident with the 648th of Rome (41).

2. No dates ever occurred upon the medals of the Syrian kings presiding over the people of Sidon, either to F. Frœlich or Dr. Vaillant (42), who have so eminently distinguished themselves in this branch of literature, before the year of Seleucus 112; and therefore neither the Phœnician dates preserved on the aforesaid Sidonian coins whose numeral characters do not amount to 112, nor the Greek dates on others falling short of that number, can rationally be supposed to bear any relation to the æra of that prince. This certainly must be considered as a strong presumption, or rather an incontestable proof, that the last-mentioned Phœnician dates were deduced from the commencement of the proper Sidonian epoch, as from their genuine cardinal point. Which reasoning will by analogy extend, as the numeral characters exhibited by all the coins here explained are of the same kind, to every one of the rest.

3. None of the medals of the Syrian kings, with Phœnician letters upon them (43), hitherto published, bear any Phœnician dates. This, after what has been said, renders it extremely probable, that the pieces of Sidon I am considering were posterior to those coins; and even that their Phœnician dates referred to an æra different from that of Seleucus, followed by the Greek dates on the medals of the Syrian kings. Which if we admit, this æra could have been

(41) F. Fienr. Nor. Veronens. ubi sup.

(42) Erasim. Frœl. ubi sup. p. 39. Joan. Foy-Vaill. *Seleucidar. Imper.* p. 1—150. Lutet. Parisior. 1681.

(43) Joan. Foy-Vaill. Erasim. Frœl. Nicol. Haym Roman. &c.

no other than the new one of the Sidonians, that commenced in the seventh century of Rome.

4. That the dates visible on these coins were supposed according to the latter epoch of Sidon, will be manifest from an examination of the Greek and Phœnician brass medals of that city explained, in (44) the beginning of this paper; whose type and workmanship are extremely similar, if not almost intirely the same. For this circumstance is to me an evident proof, that they could not have been struck at very distant times. Now if we take the Greek coin to have followed the æra of Seleucus, as was undoubtedly the case, and the others that peculiar to Sidon; the first of the Phœnician dates (45) will not be prior to the Greek one above fifty-three years, nor the last of them precede it above forty-three years. Whereas if we suppose the numeral inscriptions in the exergues of the Phœnician Sidonian coins to have been supposed according to the Seleucian epoch, the difference between the aforesaid dates will be five times as much; which with the similarity of workmanship and type, already observed, will be altogether incompatible.

5. As the Jews (46), about the time that the first of our medals was struck, denominated the æra of Seleucus, **THE ÆRA OF THE KINGDOM OF THE GREEKS**; we cannot well doubt but it went amongst the Sidonians, who were neighbours to the Jews, under the same denomination. From whence it will follow, that the epoch styled by them emphatically, **THE ÆRA OF SIDON**, must have been different from the æra of Seleucus; and conse-

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(44) See above, p. 793, 794.

(45) Erasmi Froel. ubi sup. p. 103.

(46) 1. Maccab. i. 10.





PHŒNICIAN Numerals, antiently used at SIDON,  
from *One* to a *Thousand*.

XL	NN	I	/
L	NN	II	//
LX	NNN	III	///
LXX	NNN	IV	////
LXXX	NNNN	V	/////
LXXX	NNNN	VI	//////
XC	NNNN	VII	////////
		VIII	/////////
		IX	//////////
C	<p> <i>               P \ / / / / / \ / / / / /             </i> </p> <p> <i>               / / / / / \ / / / / /             </i> </p> <p> <i>               P / / / / / \ / / / / /             </i> </p> <p> <i>               P / / / / / \ / / / / /             </i> </p>	X	<p> <i>               P - h             </i> </p>
		XI	/
		XII	//
		XIII	///
		XIV	////
CC	P //	XV	////
CCC	/ / / /	XVI	////
CCCC	/ / / / /	XVII	////
D	P / / / /	XVIII	////
DC	P / / / / /	XIX	////
DCC	P / / / / /	XX	NNNN
DCCC	P / / / / /		<p> <i>               Palm.             </i> </p> <p> <i>               N 2 2             </i> </p>
DCCC	P / / / / /	XXI	/N
DCCCC	P / / / / /	XXII	//N
////////-NNNN	<p> <i>               / / / / /             </i> </p>	XXIII	///N
DCCCCXCIX	<p> <i>               / / / / /             </i> </p>	XXIV	////N
		XXV	////N
		XXX	-N

quently that which, after the 643d year of Rome, was peculiar to them.

The powers of the Phœnician numeral characters antiently used at Sidon, which I flatter myself are now discovered, having been for many ages unknown; the Society will perhaps not be displeased to see accurate draughts of the principal Phœnician medals, from whence they are deduced. I have therefore taken the liberty to transmit them (47) such draughts, which may be intirely depended upon. I have also constructed a table (48) of the numeral characters themselves, from UNITY to A THOUSAND; which will demonstrate, in the clearest manner possible, the great affinity between them and those of the Palmyrenes.

1. From this table it plainly appears, that the people of Sidon had no particular character to denote FIVE, whilst the Phœnician numerals here explained were in vogue amongst them; that they expressed TWENTY by a character, during that period, not very different from the correspondent one used at Tadmor; and that in all other respects the Phœnician notation then prevailing at Sidon was, in a manner, the same with that of the (49) Palmyrenes.

2. It may not be improper to observe, that two of the Sidonian coins I have been considering (50)

(47) See Plate xxxi.

(48) See Plate xxxii.

(49) It may not however be amiss to remark, that most of the forms of the Phœnician centenary and decimal numeral characters rather resemble the correspondent Palmyrene numerals of Gruter than those of Mr. Dawkins; as will be obvious to every one, who shall think proper to compare all those different characters one with another. *Philosophr. Transact.* Vol. xlviii. Par. ii. p. 721, 741.

(50) See Plate xxxi. Fig. 5. & Arigon. Tab. II. Num. ix.

exhibit the Phœnician word **𐤏𐤍**, equivalent to the Hebrew **מאה**, and Syriac **ܡܢܐ**, AN HUNDRED, instead of the centenary numeral character. This, in conjunction with the appearance of that character, occupying the very place of the term **𐤏𐤍**, on others of those coins, first induced me to believe, that the inscription preserved by every one of them in the exergue could be nothing else but a date.

3. I shall beg leave farther to remark, that none of the indubitable medals of Tyre, adorned with Phœnician letters, as far as I have been able to discover, present to our view any Phœnician dates at all. This still more clearly evinces the second element prefixed to the Phœnician numerals in the exergue to point out to us the city of Sidon, and not that of Tyre; which (51), indeed, seems already to have been sufficiently proved.

4. From the foregoing observations we may likewise collect, that the coin assigned to Demetrius III. by Mr. Maffon, F. Frœlich (52), and Sig. Haym, exhibiting a Phœnician legend, without a Phœnician date, in the exergue, ought in reality to be attributed to Demetrius I. Those three learned men therefore have been guilty of a mistake in this particular. Nor can the head on this medal be denied to bear some resemblance to that of Demetrius I. (53) with a moderate beard, as it appears on a coin published by Dr. Vaillant, and in one of F. Frœlich's plates.. That the letters A K, behind the head, in-

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(51) See above, p. 791, 792.

(52) Nicol. Haym Roman. ubi sup. p. 100. Erasmi. Frœl. ubi sup. p. 111. Tab. XV.

(53) Joan. Foy-Vaill. ubi sup. p. 238. Erasmi. Frœl. ubi sup. p. 57. Tab. VII. Num. 1.

dicating the piece to have been struck in the twenty-first year of the proper Sidonian æra (54), as Mr. Maffon and F. Frœlich are pleased to assert, can never be proved. On the contrary, the improbability of such a notion may be inferred from two similar letters, behind the turrit head of the *Dea Syria* (55), on a Phœnician coin, which Mr. Maffon makes to point out the forty-first year of the proper epoch of Sidon; whereas, in truth, that piece seems to have been struck either in the reign of Demetrius I. or Antiochus IV. (56) many years before. Nay, that it was actually struck when Demetrius I. sat upon the Syrian throne, is rendered almost incontestable by a medal of that prince now in my possession, with a *Beta* behind the head on the anterior part, and the very reverse of the last-mentioned coin. From the former of which circumstances it farther appears, that the alphabetic characters MA, supposed by Mr. Maffon to denote 41, are by no means to be taken for a date. To which we may add, that the head on a Phœnician medal, with the two Greek elements AK behind it, published by Mr. Reland (57), is apparently that of Demetrius I.; and that the posterior part of this coin is nearly the same, in all respects, with the reverse of that supposed to (58) appertain to Demetrius III. by Mr. Mas-

(54) Nicol. Haym Roman. ubi sup. p. 101. Erasmi. Frœl. ubi sup. p. 111.

(55) Nicol. Haym Roman. ubi sup. p. 105, 106.

(56) Joan. Foy-Vaill. ubi sup. p. 200. Erasmi. Frœl. ubi sup. p. 63. Tab. VIII. Num. 30.

(57) Hadr. Reland. *Palæst. Illustrat.* p. 1014.

(58) Nicol. Haym Roman. ubi sup. p. 100, 101.

son and Sig. Haym. But to wave all other considerations, relative to the point in view, that may occur, the features and turns of the face on the medals of Demetrius III. are so different (59), that no inference of any validity can be drawn from the pretended identity or similitude of them, in support of Mr. Mafson's opinion.

5. The Palmyrene and Phœnician numerals, deduced from coins and inscriptions, may perhaps be thought not unworthy a place amongst the arithmetical characters of various nations, formerly (60) collected by Bishop Beveridge; and consequently may be allowed to render somewhat more complete the chronological institutions, or rather the chronological arithmetic, of that learned and judicious author.

You will pardon the prolixity of this letter, which the novelty of the subject may perhaps render a little more excusable than it would otherwise have been; and believe me to be, with the most perfect consideration and esteem,

SIR,

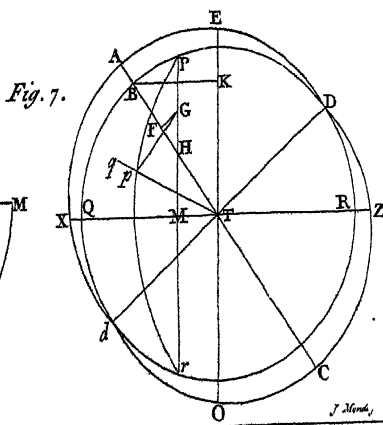
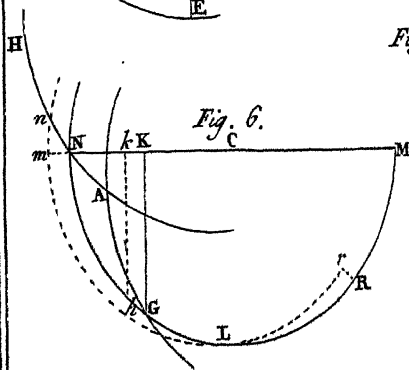
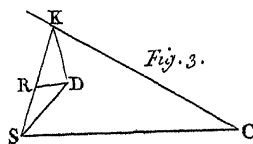
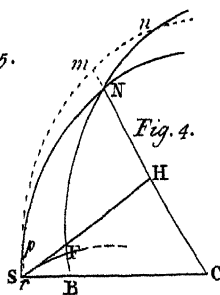
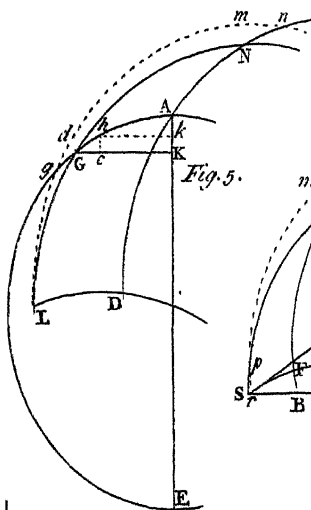
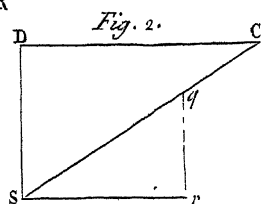
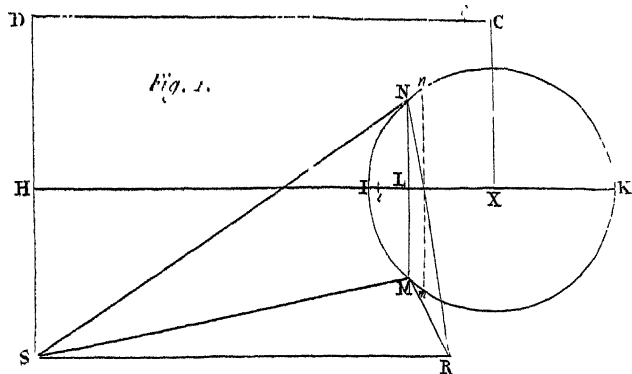
Your most obedient humble Servant,

Christ Church, Oxon.  
Nov. 17. 1758.

J. Swinton.

(59) Joan. Foy-Vaill. ubi sup. p. 375, 378. Haym, ubi sup. p. 100. Erasmi. Froel. ubi sup. p. 121. Tab. XV.

(60) Gul. Bevereg. *Institut. Chronologic.* p. 278—331. Bond. 1721.





*CX. Of the Irregularities in the Motion of a Satellite arising from the spheroidical Figure of its Primary Planet: In a Letter to the Rev. James Bradley D. D. Astronomer Royal, F. R. S. and Member of the Royal Academy of Sciences at Paris; by Mr. Charles Walmesley, F. R. S. and Member of the Royal Academy of Sciences at Berlin, and of the Institute of Bologna.*

‘Reverend Sir,’

Read Dec. 14,  
1758.

**S**INCE the time that astronomers have been enabled by the perfection of their instruments to determine with great accuracy the motions of the celestial bodies, they have been solicitous to separate and distinguish the several inequalities discovered in these motions, and to know their cause, quantity, and the laws according to which they are generated. This seems to furnish a sufficient motive to mathematicians, wherever there appears a cause capable of producing an alteration in those motions, to examine by theory what the result may amount to, though it comes out never so small: for as one can seldom depend securely upon mere guess for the quantity of any effect, it must be a blameable neglect entirely to overlook it without being previously certain of its not being worth our notice.

Finding therefore it had not been considered what effect the figure of a planet differing from that of a



sphere might produce in the motion of a satellite revolving about it, and as it is the case of the bodies of the Earth and Jupiter which have satellites about them, not to be spherical but spheroidal, I thought it worth while to enter upon the examination of such a problem. When the primary planet is an exact globe, it is well known that the force by which the revolving satellite is retained in its orbit, tends to the center of the planet, and varies in the inverse ratio of the square of the distance from it; but when the primary planet is of a spheroidal figure, the same rule then no longer holds: the gravity of the satellite is no more directed to the center of the planet, nor does it vary in the proportion above-mentioned; and if the plane of the satellite's orbit be not the same with the plane of the planet's equator, the protuberant matter about the equator will by a constant effort of its attraction endeavour to make the two planes coincide. Hence the regularity of the satellite's motion is necessarily disturbed, and though upon examination this effect is found to be but small in the moon, the figure of the earth differing so little from that of a sphere, yet in some cases it may be thought worth notice; if not, it will be at least a satisfaction to see that what is neglected can be of no consequence. But however inconsiderable the change may be with regard to the moon, it becomes very sensible in the motions of the satellites of Jupiter both on account of their nearer distances to that planet when compared with its semidiameter, as also because the figure of Jupiter so far recedes from that of a sphere. This I have shewn and exemplified in the fourth satellite; in which case indeed the computation is more exact

exact than it would be for the other satellites: for as my first design was to examine only how far the moon's motion could be affected by this cause, I supposed the satellite to revolve at a distance somewhat remote from the primary planet, and the difference of the equatoreal diameter and the axis of the planet not to be very considerable. There likewise arises this other advantage from the present theory, that it furnishes means to settle more accurately the proportion of the different forces which disturb the celestial motions, by assigning the particular share of influence which is to be ascribed to the figure of the central bodies round which those motions are performed.

I have added at the end a proposition concerning the diurnal motion of the earth. This motion has been generally esteemed to be exactly uniform; but as there is a cause that must necessarily somewhat alter it, I was glad to examine what that alteration could amount to. If we first suppose the globe of the earth to be exactly spherical, revolving about its axis in a given time, and afterwards conceive that by the force of the sun or moon raising the waters its figure be changed into that of a spheroid, then according as the axis of revolution becomes a different diameter of the spheroid, the velocity of the revolution must increase or diminish: for, since some parts of the terraqueous globe are removed from the axis of revolution and others depressed towards it, and that in a different proportion as the sun or moon approaches to or recedes from the equator, when the whole quantity of motion which always remains the same is distributed through the spheroid, the velocity of the diurnal rotation cannot be constantly the same. This

variation however will scarce be observable, but as it is real, it may not be thought amiss to determine what its precise quantity is.

I am sensible the following theory, as far as it relates to the motion of Jupiter's satellites, is imperfect and might be prosecuted further; but being hindered at present from such pursuit by want of health and other occupations, I thought I might send it you in the condition it has lain by me for some time. You can best judge how far it may be of use, and what advantage might arise from further improvements in it. I am glad to have this opportunity of giving a fresh testimony of that regard which is due to your distinguished merit, and of professing myself with the highest esteem,

Reverend Sir,

Your very humble Servant,

Bath, Oct. 21.  
1758.

C. Walmesley.

# LEMMA I.

*Invenire gravitatem corporis longinqui ad circumferentiam circuli ex particulis materiæ in duplicatâ ratione distantiarum inversè attrahentibus constantem.*

**E**STO NIK (Vid. TAB. xxxiii. Fig. 1.) circumferentia circuli, in cujus puncta omnia gravitet corpus longinquum S locatum extra planum circuli. In hoc planum agatur linea perpendicularis SH, et per circuli centrum X ducatur recta H X K secans circumulum in I et K, et SR parallela ad H X: producatu' autem SH ad distantiam datam SD, et agantur rectæ DC,

DC, XC, ipsis HX, SD, parallelæ. Tum ductâ chordâ quavis MN ad diametrum IK normali eamque secante in L, ex punctis M, N, demittantur in SR perpendiculares MR, NR, concurrentes in R; junctisque SM, SN, erit  $SM = SN$ ,  $MR = NR$ ,  $SR = HL$ . Dicantur jam SD,  $k$ ; HX five DC,  $h$ ; XL,  $x$ ; CX,  $z$ ; XI,  $r$ ; eritque  $HL = b - x$ , et  $SH = k - z$ . Est autem SM ad SH ut attractio

$\frac{1}{SM^2}$  corporis S versus particulam M in directione SM ad ejusdem corporis attractionem in directione SH, quæ proinde erit  $\frac{SH}{SM^3}$ : sed est  $SR = HL$ , et

$$\overline{SM}^2 = \overline{SR}^2 + \overline{MR}^2 = \overline{SR}^2 + \overline{SH}^2 + \overline{ML}^2; \text{ unde fit}$$

$$\frac{SH}{SM^3} = \frac{SH}{\overline{HL}^2 + \overline{SH}^2 + \overline{ML}^2^{\frac{3}{2}}}, \text{ et ductâ } mn \text{ parallelâ}$$

ad MN, vis qua corpus S attrahitur ad arcus quàm minimos Mm, Nn, exponitur per  $\frac{SH \times 2 Mm}{SM^3} =$

$$SH \times 2 Mm \times \overline{HL}^2 + \overline{SH}^2 + \overline{ML}^2^{-\frac{3}{2}}. \text{ Est autem}$$

$$\overline{HL}^2 + \overline{SH}^2 + \overline{ML}^2 = kk - 2kz + zz + bb - 2bx + rr,$$

$$\text{hincque ponendo } kk + bb = ll, \overline{HL}^2 + \overline{SH}^2 = \overline{ML}^2^{-\frac{3}{2}} =$$

$$\frac{1}{l^3} + \frac{3kz}{l^5} + \frac{3bx}{l^5} - \frac{3rr}{2l^5} - \frac{3zz}{2l^5} + \frac{15kkzz}{2l^7} + \frac{15bbzz}{2l^7} +$$

$$\frac{15bbxx}{2l^7}, \text{ neglectis terminis ulterioribus ob longinquitatem quam supponimus corporis S. Quare, si scribatur } d \text{ pro circumferentiâ IMKN, gravitas corporis}$$

S ad totam illam circumferentiam secundum SH, five fluens fluxionis  $SH \times 2 Mm \times \overline{HL}^2 + \overline{SH}^2 + \overline{ML}^2^{-\frac{3}{2}}$

$$\text{evadit } k - z \times d \text{ in } \frac{1}{l^3} + \frac{3kz}{l^5} - \frac{3rr}{2l^5} - \frac{3zz}{2l^5} +$$

$\frac{15kkzz}{2l^7} + \frac{15bbt}{4l^7}$ . Simili modo obtinebitur gravitas ejusdem corporis S secundum SR. *Q. E. I.*

# LEMMA II.

*Corporis longinqui gravitatem ad Sphæroidem oblatam determinare.*

Retentis iis quæ sunt in lemmate superiori demonstrata; esto C centrum sphæroidis, cujus æquatori parallelus sit circulus IMK. Sphæroidis hujus semiaxis major sit  $a$ , semiaxis minor  $b$ , eorum differentia  $c$ , quam exiguam esse suppono; et dicatur D circumferentia æquatoris. Centro C et radio æquali semiaxi minori describi concipiatur circulus qui secet IK in  $i$ , eritque gravitas in directione SD, qua urgetur corpus S versus materiam sitam inter circumferentiam IMKN et circumferentiam centro X et radio Xi descriptam, æqualis gravitati in lemmate præcedenti definitæ ductæ in rectam Ii. Sed est  $Ii . c :: IX . a$ , atque  $d . D :: IX . a$ ; unde  $Ii \times d . D \times c :: IX^2 . aa$ , hoc est, ex naturâ ellipseos, ob  $CX = z$ , et  $IX = r$ ,  $Ii \times d . D \times c :: bb - zz . bb$ , adeoque  $Ii \times d = \frac{D \times c}{bb} \times \overline{bb - zz}$ , atque  $rr = aa - \frac{aa \times z}{bb}$ ; scribi autem potest in sequenti calculo  $bb - zz$  pro  $rr$  ob parvitatem differentię semiaxium in quam omnes termini ducuntur. Gravitas igitur corporis S in materiam inter circumferentias supradictas consistentem exprimetur per  $\frac{D \times c}{bb} \times \overline{bb - zz} \times \overline{k - z}$  in  $\frac{1}{l^3} + \frac{3kz}{l^5} - \frac{3bb}{2l^5} - \frac{15zz}{4l^5} + \frac{15bbbb}{4l^7} + \frac{45kkzz}{4l^7}$ . Et si addatur gravitas in similem materiam

ex

ex alterâ parte centri C ad æqualem à centro distan-  
tiam, quia tunc CX five  $z$  evadit negativa, gravitas  
corporis S in hanc duplicem materiam erit  $\frac{D \times c}{bb} \times$   
 $\frac{bb - zz}{bb}$  in  $\frac{2k}{l^3} - \frac{6kzz}{l^5} - \frac{3kbb}{l^5} + \frac{15k^3zz}{l^7} + \frac{15bbkbb}{2l^7} -$   
 $\frac{15bbkzz}{2l^7}$ . Ducatur jam gravitas hæc in  $z$ , et sumptâ  
gravitatum omnium summâ, factâ  $z = b$ , gravitatio  
tota corporis S in totam materiam globo interiori su-  
periolem secundum directionem SD æquatori per-  
pendicularem prodit  $D \times c \times \frac{4kb}{3l^3} - \frac{4kb^3}{5l^5} + \frac{2kbb^3}{l^7}$ .  
Simili ratiocinio gravitatio corporis S in eandem  
materiam secundum directionem SR æquatori pa-  
rallelam invenitur æqualis  $D \times c \times \frac{4bb}{3l^3} + \frac{2bb^3}{5l^5} -$   
 $\frac{2bkkbb^3}{l^7}$ . Tum si addatur gravitatio corporis S in  
globum interiorem, ex unâ parte scilicet  $\frac{2b^3kD}{3al^3}$ , et  
ex alterâ  $\frac{2b^3bD}{3al^3}$ , habebitur gravitas corporis S in to-  
tum sphæroidem. Q. E. I.

# COROLL.

Igitur gravitas corporis S secundum SD est ad ejus-  
dem gravitatem secundum SR five DC in materiam  
sphæroidis globo interiori incumbentem ut  $\frac{2k}{3} - \frac{2kb^2}{5l^2}$   
 $+ \frac{kbb^2}{l^4}$  ad  $\frac{2b}{3} + \frac{bb^2}{5l^2} - \frac{bkkbb^2}{l^4}$ , adeoque si gravitas prior  
exponatur per  $k$ , posterior exprimetur per  $b - \frac{3bb^2}{5l^2}$   
quamproximè. Unde cum fit  $DC = b$ , patet gravi-  
tatem corporis S in sphæroidem oblatam non tendere  
ad

ad centrum C, sed ad punctum *c* rectæ DC in plano æquatoris jacentis vicinius puncto D.

# PROPOSITIO I.

## PROBLEMA.

*Vires determinare quibus perturbatur motus Satellitis circa Præmarium suum revolvantis.*

Exhibeat jam sphærois prædicta planetam quemvis figurâ hac donatum, et corpus S satellitem circa planetam tanquàm præmarium gyran- tem. Quantitas materiæ globo sphæroidis interiori incumbentis æqualis est  $\frac{4bbcD}{3a}$  five  $\frac{4bcD}{3}$  proximè, et si materia illa locaretur in centro sphæroidis C, attraheret satellitem S secundum SC vi  $\frac{4bcD}{3l^2}$ , quæ reducta ad directionem SD fit  $\frac{4bckD}{3l^3}$ , et ad directionem DC fit  $\frac{4bcbD}{3l^3}$ . Cum igitur vis  $\frac{4bcD}{3l^2}$  non turbat motum satellitis, utpote quæ tendat ad centrum motûs et quadrato distantiae ab eodem centro fit reciprocè proportionalis, vires illæ  $\frac{4bckD}{3l^3}$ ,  $\frac{4bcbD}{3l^3}$ , in quas resolvitur, etiam motum non turbabunt. Itaque ex vi  $D \times c \times \frac{4kb}{3l^3} - \frac{4kb^3}{5l^5} + \frac{2kbb^3}{l^7}$  auferatur vis  $\frac{4bckD}{3l^3}$ , et ex vi  $D \times c \times \frac{4bb}{3l^3} + \frac{2bb^3}{5l^5} - \frac{2bkkb^3}{l^7}$  auferatur  $\frac{4bcbD}{3l^3}$ , et remanebunt vires  $D \times c \times \frac{4kb^3}{5l^5} + \frac{2kbb^3}{l^7}$ ,  $D \times c \times \frac{2bb^3}{5l^5} - \frac{2bkkb^3}{l^7}$ , motuum satellitis S perturbatrices. Designetur vis  $D \times c \times$

$\frac{2kb^3}{5l^5} - \frac{2bbkb^3}{l^7}$  per rectam  $Sr$  (*Fig. 2.*) ac resolvatur in vim  $Sq$  tendentem ad centrum planetæ primariæ  $C$  et ob triangu-  
la similia  $Srq$ ,  $SDC$ , æqualem  $D \times c \times \frac{2b^3}{5l^4} - \frac{2kkb^3}{l^6}$ , existentibus ut priùs,  $SD = k$ ,  $DC = b$ ,  $SC = l$ ;  
et in vim  $rq$  rectæ  $SD$  parallelam et æqualem  $D \times c \times \frac{2kb^3}{5l^5} - \frac{2k^3b^3}{l^7}$ ; atque hæc vis posterior subducta ex vi  
 $D \times c \times -\frac{4kb^3}{5l^5} + \frac{2kbb^3}{l^7}$  relinquet  $D \times c \times \frac{4kb^3}{5l^5}$  pro  
vi perturbatrice in directione  $SD$ . Unde cum massa  
tota planetæ sit  $\frac{2abD}{3}$ , gravitas satellitis tota in plane-  
tam erit  $\frac{2abD}{3l^2}$  proximè, vel etiam  $\frac{2bbD}{3l^2}$ , et hæc gravi-  
tas est ad vim  $D \times c \times \frac{4kb^3}{5l^5}$  ut 1 ad  $\frac{6kbc}{5l^3}$ .

Deinde vis illius  $D \times c \times \frac{4kb^3}{5l^5}$  secundum  $SD$  pars  
ea quæ agit in directione  $SC$  est  $D \times c \times \frac{4kkb^3}{5l^6}$ , quæ  
addita vi  $Sq$  dat  $D \times c \times \frac{2b^3}{5l^4} - \frac{6kkb^3}{5l^6}$  vim perturbatri-  
cem tendentem ad centrum planetæ primariæ, atque hæc  
vis est ad satellitis gravitatem  $\frac{2bbD}{3l^2}$  in primarium ut  
 $\frac{3bc}{5l^2} - \frac{9kkbc}{5l^4}$  ad 1. *Q. E. I.*

## COROLL.

Designet  $CK$  (*Fig. 3.*) lineam intersectionis plano-  
rum æquatoris planetæ et orbitæ satellitis, et resolu-  
tur vis  $SD = \frac{6kbc}{5l^3}$ , quæ agit perpendiculariter ad



planum æquatoris, in vim DR perpendicularem ad planum orbitæ satellitis, et in vim SR jacentem in eodem plano. Producatur SR donec occurrat CK in K, eritque SK normalis ad CK, et planum SDK normale ad planum orbis satellitis; ac propterea ob similia triangula SDK, SRD, si  $m$  denotet sinum ad radium 1 et  $n$  cosinum anguli SKD, inclinationis scilicet orbitæ satellitis ad æquatorem planetæ, erit  $DR = SD \times n = \frac{6kbcn}{5l^3}$ , et  $SR = SD \times m = \frac{6kbcm}{5l^3}$ ,

existente 1 gravitate totâ satellitis in primarium suum. Jam quoniam vis SR jacet in plano orbitæ satellitis, hujus plani situm non mutat; accelerat quidem vel retardat motum satellitis revolventis, sed hæc acceleratio vel retardatio ob brevitatem temporis ad quantitatem sensibilem non exurgit: vis DR eidem plano perpendicularis continuò mutat ejus situm, et motum nodi generat, quem sequenti propositione definiemus.

## OPPOSITIO II.

### PROBLEMA.

*Invenire motum nodi ex prædictâ causâ oriundum.*

Per motum nodi in hac propositione intelligo motum intersectionis planorum æquatoris planetæ et orbitæ satellitis; orbitam autem satellitis quamproximè circulem suppono. Esto S locus satellitis in orbe suo SN cujus centrum C, (Fig. 4.) SF arcus centro C descriptus perpendicularis in circulum æquatoris planetæ EN; SB arcus eodem centro descriptus perpendicularis ad orbem SN, atque in SB sumatur lineola Sr æqualis duplo spatio, quod satelles percurrere posset impellente vi DR in Coroll. præced. deter-

determinatâ, quo tempore in orbe suo describeret arcum quàm minimum  $pS$ : per puncta  $r, p$ , describatur centro  $C$  circulus  $rp n$  secans equatorem in  $n$ , qui exhibebit fitum orbitæ satellitis post illam particulam temporis, nodo  $N$  translato in  $n$ . Agantur  $SC, CN$ , et  $SH$  perpendicularis in lineam nodorum  $CN$ , et  $Nm$  perpendicularis in  $rp n$ . Jam cum sint lineolæ  $Sr, Nm$ , ut sinus arcuum  $Sp, SN$ , erit  $Sp . Sr :: SH . Nm$ ; deinde in triangulo rectangulo  $Nmn$  habetur  $m . 1 :: Nm . Nn$ ; unde per compositionem rationum  $Sp \times m . Sr :: SH . Nn = \frac{Sr \times SH}{Sp \times m}$ :

dato igitur arcu  $Sp$ , est  $Nn$  five motus nodi ut  $Sr \times SH$ . In triangulo sphærico rectangulo  $SPN$  est sinus anguli  $N$ , hoc est, anguli inclinationis orbitæ satellitis ad æquatorem planetæ, ad finem arcûs  $SF$ , ut radius ad finem arcûs  $SN$ , id est,  $m . \frac{k}{l} :: 1 . SH$ , adeoque  $\frac{k}{l} = m \times SH$ ; est igitur  $\frac{k}{l}$  ut  $SH$ . Vis autem  $Sr$  per Coroll. Prop. præced. est ut  $\frac{k}{l}$ , adeoque ut  $SH$ ; quamobrem est  $Sr \times SH$ , proindeque et  $Nn$ , ut  $\overline{SH}^2$ , hoc est, motus horarius nodi vi præfatâ genitus est in duplicatâ ratione distantiae satellitis à nodo. Et quoniam summa omnium  $\overline{SH}^2$ , quo tempore satelles periodum suam absolvit, est dimidium summæ totidem  $\overline{SC}^2$ , idè motus periodicus est subduplus ejus qui, si satelles in declinatione suâ maximâ ab æquatore planetæ continuo perstaret, eodem tempore generari posset. Sit igitur satelles in maximâ suâ declinatione five in quadraturâ cum nodo, eritque  $SN$  quadrans circuli, et  $Nm$  mensura anguli  $Npm$ , five  $Spr$ , eritque in hoc casu  $Nn$  five motus horarius nodi ad  $Nm$ , hoc est, ad angulum  $Spr$ , ut 1 ad  $m$ ;

est autem angulus  $Spr$  ad duplum angulum, quem subtendit sinus versus arcus  $S\hat{p}$  satellitis gravitate in primum eodem tempore descripti, id est, ad angulum  $SC\hat{p}$  qui est motus horarius satellitis circa primum, ut vis  $Sr$  ad gravitatem satellitis in primum, hoc est (per Coroll. Prop. I.), ut  $\frac{6kbcn}{5l^3}$

ad 1, five, quia est in hoc casu  $\frac{k}{l} = m$ , ut  $\frac{6bcmn}{5l^2}$  ad 1. Unde conjunctis rationibus est motus horarius nodi ad motum horarium satellitis ut  $\frac{6bcn}{5l^2}$  ad 1; et si

$S$  denotet tempus periodicum solis apparens, et  $L$  tempus periodicum satellitis circa primum suum, cum sit motus horarius satellitis ad motum horarium solis ut  $S$  ad  $L$ , erit motus horarius nodi ad motum horarium solis ut  $\frac{6bcn}{5l^2} \times \frac{S}{L}$  ad 1, et in eadem ratione erit

motus nodi annuus ad motum solis annum, hoc est, ad  $360^\circ$ . Quare, si satelles maneret toto anno in maximâ suâ declinatione ab æquatore primarii, vis prædicta ex figurâ sphæroidicâ planetæ primarii proveniens generaret eodem tempore motum nodi æqua-

lem  $\frac{6bcn}{5l^2} \times \frac{S}{L} \times 360^\circ$ , et ex supradictis motus verus nodi annuus erit hujus subduplus, nempe  $\frac{3bcn}{5l^2} \times \frac{S}{L} \times 360^\circ$ . *Q. E. I.*

#### COROLL.

Si computatio instituat pro lunâ, assumendo mediocrem ejus orbitæ inclinationem ad æquatorem terrestrem, erit  $\cosinus$  anguli  $23^\circ 28' \frac{1}{4}$ ; et posito semiaxi terræ  $b = 1$ , erit distantia lunæ à centro terræ mediocris  $l = 60$  circiter, indeque in hypothese quod fit

fit differentia femiaxium  $c = \frac{1}{229}$ , erit  $\frac{3bcn}{5l^2} \times \frac{S}{L} \times 360^\circ = 11''\frac{1}{4}$ ; et si fuerit  $c = \frac{1}{177}$ , manente terrâ uniformiter densâ, erit ille motus  $= 15''$ . Hic erit motus nodorum annuus lunæ regressivus in plano æquatoris terrestris, qui reductus ad eclipticam, uti postea docebitur, pro vario nodorum situ evadet multò velocior.

Notabilis multò magis erit motus interfectionis orbitalium satellitum Jovis in plano æquatoris Jovialis; et computabitur satis accuratè per formulam suprâ traditam, modò satelles non sit Jovi nimis vicinus. Sic pro satellite extimo erit  $L = 16^d 16^h 32'$ ,  $b = 1$ ,  $l = 25,299$  circiter, femiaxium Jovis differentia  $c = \frac{1}{13}$ ; et positi orbis hujus satellitis inclinatione ad æquatorem Jovis æquali  $3^\circ$ , erit  $n$  cosinus hujus inclinationis, atque inde prodibit  $\frac{3bcn}{5l^2} \times \frac{S}{L} \times 360^\circ = 34'$  circiter, motus scilicet nodorum annuus satellitis quarti in plano æquatoris Jovis in antecedentia. Si minùs vel magis inclinatur orbis ad Jovis æquatorem, augeri vel minui debet hic motus in ratione cosinùs hujus inclinationis.

Cæterùm patet motum hunc nodorum in plano æquatoris planetæ primarii, æstimando distantiam satellitis in semidiametris primarii, generatim esse, dato tempore, in ratione compositâ, ex ratione directâ differentiæ femiaxium planetæ et cosinùs inclinationis orbis satellitis ad planetæ æquatorem, conjunctim; et ex ratione inversâ temporis periodici satellitis et quadrati distantiae satellitis à centro planetæ, item conjunctim.

## PROPOSITIO III.

## PROBLEMA.

*Motum nodorum Lunæ supra determinatum ad Eclipticam reducere.*

Sunto  $NAD$  (Fig. 5.) æquator,  $AGE$  ecliptica secans æquatorem in  $A$ ,  $E$  æquinoctium vernal,  $A$  autumnale,  $LGN$  orbis lunæ secans eclipticam in  $G$  et æquatorem in  $N$ ,  $LD$  circulus maximus perpendicularis in æquatorem; et sunt  $DN$ ,  $LN$ , quadrantes circuli. Tempore dato vi prædictâ transferatur intersectio  $N$  in  $n$ , et describatur circulus  $Lgn$  exhibens situm orbis lunaris post illud tempus, secetque eclipticam in  $g$ . Ut autem intersectiones  $N$  et  $G$  sine verborum ambagibus distinguantur, priorem in posterum vocabo *Nodum Æquatorium*, posteriorem *Nodum Eclipticum*. Ductis itaque  $Nm$ ,  $Gd$ , perpendicularibus in orbem lunæ, est  $Nn : Nm :: 1 : \text{fin. } GNA$ , et  $Nm : Gd :: 1 : \text{fin. } LG$ , itemque  $Gd : Gg :: \text{fin. } Ggd : 1$ ; unde conjunctis rationibus provenit  $Nn : Gg :: \text{fin. } Ggd : \text{fin. } GNA \times \text{fin. } LG$ , adeoque  $Gg = Nn \times \frac{\text{fin. } GNA \times \text{fin. } LG}{\text{fin. } Ggd}$ . Scribantur  $s$  pro sinu et  $t$  pro cosinu anguli  $Ggd$ , inclinationis scilicet orbitæ lunaris ad eclipticam, ad radium 1,  $v$  pro sinu et  $u$  pro cosinu arcûs  $EG$ ,  $p$  pro sinu et  $q$  pro cosinu obliquitatis eclipticæ; atque per resolutionem trianguli spherici  $GAN$ , habebitur  $\cos. GNA = n = \frac{qt + psu}{\sqrt{1 - qqt - 2pqstu - p^2s^2u^2}}$ , sed scribi potest 1 pro  $t$ , et rejici terminus  $p^2s^2u^2$  ob exiguitatem sinûs  $s$  anguli

5° 8'  $\frac{1}{2}$ , proindeque erit fin. GNA' =  $\sqrt{pp - 2pqsu}$ ; præterea est fin. GNA : fin. GA five  $v ::$  fin. GAN five  $p : \text{fin. GN}$ , ideoque fin. GN five cos. LG =  $\frac{pv}{\text{fin. GNA}}$ , et fin. LG =  $u - \frac{qsvv}{p}$ , ac fin. GNA  $\times$  fin. LG =  $pu - qs$  quamproximè. Quare fit Gg =  $Nn \times \frac{pu - qs}{s}$ , atque hic est motus nodorum lunarium tempore dato in plano eclipticæ: quod si tempus illud datum sit annus solaris, habetur  $Nn = \frac{360}{51^2} \times \frac{S}{L} \times 360^\circ$ , unde motus ille eclipticus nodorum annuus, nullâ habitâ ratione mutationis sitûs nodorum ex aliâ causâ per id temporis factæ, fiet  $\frac{3bc}{51^2} \times \overline{qt + psu} \times \frac{pu - qs}{s} \times \frac{S}{L} \times 360^\circ$ , vel etiam  $\frac{3bcq}{51^2} \times \frac{pu - qs}{s} \times \frac{S}{L} \times 360^\circ$  proximè. Q. E. I.

Quo motum nodi lunaris in hac propositione ad eclipticam reduximus, eodem prorsus ratiocinio motus nodi satellitis cujuscvis ad orbitam planetæ primarii reducetur.

# COROLL. I.

Exinde liquet nullum esse hunc motum nodi, ubi fin. LG = 0, vel etiam ubi  $pu = qs$ , quod contingit ubi orbitæ lunaris arcus GN eclipticam et æquatorem æqualis, est 90°, five ubi nodi lunares versantur in punctis declinationis lunaris maximæ, five ubi arcus AG, cujus cosinus est  $u$ , evadit æqualis 78° 5', id est, ubi nodus ascendens lunæ versatur in 11° 55' Cancrî, vel 18° 5' Sagittarii. Eritque progressus hic motus, id est, fiet secundum seriem signorum, dum nodus ascendens lunæ transit retrocedendo ab

18° 5' Sagittarii ad 11° 55' Cancrī, regressivus autem in reliquā parte revolutionis; et maximus evadit motus regressivus, ubi  $u = -1$ , id est, ubi nodus ascendens versatur in principio Arietis; et maximus progressivus, ubi  $u = 1$ , id est, ubi idem nodus occupat initium Libræ. Itaque cū motus ille nodorum annuus, de quo hīc agitur, universaliter sit æqualis  $\frac{3bcq}{5l^2} \times \frac{pu - qs}{s} \times \frac{S}{L} \times 360^\circ$ , hoc est, per Coroll. Prop. 2. æqualis  $11''\frac{1}{2} \times \frac{pu - qs}{s}$  vel  $15'' \times \frac{pu - qs}{s}$  prout differentia semiaxium terræ fuerit  $\frac{1}{2}\frac{1}{2}9$  vel  $\frac{1}{1}77$ , existentibus scilicet  $p$  sinu et  $q$  cosinu anguli  $23^\circ 28'\frac{1}{2}$ , atque  $s$  sinu anguli  $5^\circ 8'\frac{1}{2}$ ; eo anno, in cujus medio circiter nodus lunæ ascendens tenuerit principium Arietis, motus nodorum regressivus, qui et maximus, erit  $1' 2''$  vel  $1' 20''$ ; ubi verò idem nodus subierit signum Libræ, motus maximus progressivus erit  $41''$  vel  $53''$ . In aliis nodorum positionibus eodem modo computabitur.

## COROLL. II.

Si desideretur excessus regressus nodi supra progressum in integrā nodi revolutione, sequenti ratione investigabitur. Jungantur equinoctia diametro EA, in quam demittatur perpendicularum GK, et sumpto arcu Gb quem describit nodus eclipticus G quo tempore nodus equatorius N describit arcum Nn, ducatur bc perpendicularis in GK. Per hanc propositionem est  $Gg . Nn :: \frac{pu - qs}{s} . 1$ , five, quia est  $1 . u :: Gb . Gc$ , fit  $Gg . Nn :: \frac{p \times Gc}{s} - q \times Gb . Gb$ ; adeoque summa omnium Gg erit ad summam omnium

nium  $Nn$ , hoc est, motus nodi ecliptici in Integrâ sui revolutione erit ad motum nodi æquatorii eodem tempore factum, ut summa omnium in circulo quantitatum  $\frac{p \times Gc}{s} - q \times Gb$  ad summam totidem arcuum  $Gb$ , hoc est, ut  $-q$  ad 1. Signum autem  $-$  denotat motum fieri in antecedentia sive regressum nodi excedere ejusdem progressum. Unde cum motus nodi æquatorii  $N$  fit  $11''\frac{1}{2}$  vel  $15''$  quo tempore nodus eclipticus describit  $19^\circ 20'\frac{1}{2}$ , motus ille nodi æquatorii tempore nodi ecliptici periodico evadit  $11''\frac{1}{2} \times \frac{360^\circ}{19^\circ 20'\frac{1}{2}} = 3' 34''$  vel  $15'' \times \frac{360^\circ}{19^\circ 20'\frac{1}{2}} = 4' 39''$ ; quo pacto prodit motus nodi ecliptici præfatus æqualis  $q \times 3' 34''$  vel  $q \times 4' 39''$ , proindeque est radius ad cosinum obliquitatis eclipticæ ut  $3' 34''$  vel  $4' 39''$  ad motum quæsitum, nempe  $3' 16''$ , existente  $\frac{1}{219}$  differentiâ axium terræ, vel  $4' 16''$  eâ existente  $\frac{1}{177}$ : atque hic est excessus regressûs nodi supra progressum in integrâ nodi revolutione vi prædictâ genitus. Excessu igitur hoc minuatur motus nodi lunaris periodicus  $360^\circ$ , et remanebit motus ille quem generat vis solis.

## PROPOSITIO IV.

### PROBLEMA.

*Variationem inclinationis orbis lunaris ad planum eclipticæ ex figurâ terræ spheroidicâ ortam determinare.*

Esto  $ANH$  (Fig. 6.) æquator,  $AG$  ecliptica, et  $A$  punctum æquinoctii autumnalis: fit  $NGRM$  orbis lunæ secans eclipticam in  $G$  et æquatorem in  $N$ , in



quo sumantur arcus NL, GR, æquales quadrantibus circuli. Jam si nodus æquatorius N per temporis particulam vi prædictâ transferri intelligatur in  $n$ , et per punctum L describatur circulus  $nLr$ , exhibebit hic situm orbis lunæ post tempus elapsum, et si in eundem demittantur perpendiculara  $Nm$  et  $Rr$ , posterius  $Rr$  designabit variationem inclinationis orbitæ lunaris ad eclipticam eodem tempore genitam. Est autem  $Nn : Nm :: 1 : m$ , itemque  $Nm : Rr :: 1 : \sin. LR$ ; sed ob  $NL = GR$ , est  $NG = LR$ ; unde conjunctis rationibus est  $Nn : Rr :: 1 : m \times \sin. NG$ ; ex quo patet variationem inclinationis momentaneam esse proportionalem sinui distantie nodi lunaris ecliptici à nodo æquatorio. Ad diametrum NM demittatur perpendicularum GK, et existente  $Gh$  decremento arcûs NG factò quo tempore nodus æquatorius N describit arcum  $Nn$ , agatur  $hk$  parallela ipsi GK, eritque  $1 : GK$  sive  $\sin. NG :: Gh . Kk$ ; proindeque jam erit  $Nn : Rr :: Gh : m \times Kk$ , adeoque summa omnium variationum  $Rr$ , quo tempore nodus eclipticus G descripsit arcum MG, genitarum erit ad summam totidem motuum  $Nn$ , hoc est, ad motum nodi æquatorii N eodem tempore factum, ut summa omnium  $Kk$  ducta in  $m$ , ad summam totidem arcuum  $Gh$ , id est, ut  $m \times MK$  ad MG. Sit NH motus nodi N tempore revolutionis nodi G ab uno equinoctio ad alterum, eritque variatio inclinationis eodem tempore genita, hoc est, variatio tota æqualis  $\frac{2m \times NH}{MGN}$ .

Unde cum  $\frac{NH}{MGN}$  exprimat rationem motûs nodi æquatorii ad motum nodi ecliptici, prodit theorema sequens: *Est motus nodi lunaris ecliptici ad motum nodi æquatorii, ut sinus duplicatus inclinationis medio-*  
cri

*cris orbitæ lunaris ad æquatorem, ad sinum variationis totius inclinationis ejusdem orbitæ ad eclipticam.*

In hoc computo inclinationem mediocrem orbis lunaris ad æquatorem, nempe  $23^{\circ} 28' \frac{1}{2}$ , usurpo, cum in revolutione nodi tantum ex unâ parte augetur, quantum ex alterâ minuitur, et omnes minutias hîc expendere supervacaneum foret. Motus autem nodi lunaris ecliptici est ad motum nodi lunaris æquatōi ut  $19^{\circ} 20' \frac{1}{2}$  ad  $11'' \frac{1}{2}$  vel  $15''$ , sive ut 6055 vel 4642 ad 1, unde per theorema supra traditum prodit variatio inclinationis tota æqualis  $27''$  vel  $35''$ , prout differentia axium terræ statuitur  $\frac{1}{229}$  vel  $\frac{1}{177}$ . Hac igitur quantitate augetur inclinatio orbis lunaris ad eclipticam in transitu nodi ascendentis lunæ ab æquinoctio vernali ad autumnale, et tantumdem minuitur in alterâ medietate revolutionis nodi. In loco quolibet G inter æquinoctia variatio inclinationis est ad variationem totam ut sinus versus arcûs MG ad diametrum, ut patet; sive differentia inter semissem variationis totius et variationem quæsitam est ad ipsam semissem variationis totius ut cosinus arcûs MG ad radium, hoc est, ut  $u - \frac{q^{svv}}{p}$  ad 1. *Q. E. I.*

## PROPOSITIO V.

### PROBLEMA.

*Motum apsidum in orbe satellitis quamproximè circumlari, quatenus ex figurâ planetæ primarii sphaeroidicâ oritur, investigare.*

Per propositionem primam vis perturbatrix, quâ trahitur satelles ad centrum planetæ primarii, est ad

fatellitis gravitatem in ipsum primarium, ut  $\frac{3bc}{5l^2} - \frac{9kkbc}{5l^4}$  ad 1, five, quia per Prop. 2. est  $\frac{k}{l} = m \times SH$  (*Fig. 4.*) ponendo scilicet  $m$  pro sinu inclinationis orbitæ fatellitis ad æquatorem primarii, et scribendo  $y$  pro  $SH$ , ut  $\frac{3bc}{5l^2} \times 1 - 3m^2 y^2$  ad 1; et summa harum virium in totâ circumferentiâ cujus radius est 1, est ad gravitatem fatellitis toties sumptam ut  $\frac{3bc}{5l^2} \times 1 - \frac{3m^2}{2}$  ad 1. Vis igitur mediocris, quæ uniformiter agere in fatellitem supponi potest, dum revolutionem suam in orbitâ propemodum circulari absolvit, est ad ejus gravitatem in primarium ut  $\frac{3bc}{5l^2} \times 1 - \frac{3m^2}{2}$  ad 1; atque hac vi movebuntur apfides, si nulla habeatur ratio vis alterius quæ orbis radio est perpendicularis et per medietatem revolutionis fatellitis in unum sensum tendit, per alteram medietatem in contrarium. Jam quia ex demonstratis in hac et primâ propositione sequitur gravitatem fatellitis circa planetam, cujus figura est sphærois oblata, revolventis in distantia  $l$  generaliter esse ad ejusdem gravitatem in majori distantia  $L$ , ut  $\frac{1}{l^2} + \frac{B}{l^4} \times 1 - \frac{3m^2}{2}$  ad  $\frac{1}{L^2} + \frac{B}{L^4} \times 1 - \frac{3m^2}{2}$ , existente  $B$  quantitate datâ exigui valoris, five ut  $\frac{1}{l^2}$  ad  $\frac{1}{L^2} - \frac{B}{l^2 L^2} \times 1 - \frac{3m^2}{2} + \frac{B}{L^4} \times 1 - \frac{3m^2}{2}$  quamproximè, ideò grâvitas fatellitis diminuitur in majori quam duplicatâ ratione distantia auctæ quoties  $m$  minor est quantitate  $\sqrt{\frac{2}{3}}$ , id est, ubi inclinatio orbitæ fatellitis ad planetæ æquatorem non attingit  $54^\circ 44'$ ;

44'; diminuitur autem in minori ratione, quoties est  $m$  major quàm  $\sqrt{\frac{2}{3}}$ , id est, ubi illa inclinatio superat  $54^{\circ} 44'$ ; adeoque in priore casu progrediuntur apfides orbis satellitit, in posteriori regrediuntur. Quantitas autem hujus progressûs vel regressûs sic innotescet.

Per exemplum tertium prop. 45. lib. I. *Princ. Math. Newt.* si vi centripetæ, quæ est ut  $\frac{1}{p}$ , addatur vis altera ut  $\frac{e}{p}$ , hoc est, quæ sit ad vim centripetam  $\frac{1}{p}$  ut  $\frac{e}{p}$  ad 1, angulus revolutionis ab apfide unâ ad eandem erit  $360^{\circ} \sqrt{\frac{1+e}{1-e}}$  vel  $\frac{360^{\circ}}{1-e}$  quamproximè, existente  $e$  quantitate valdè minutâ. Porrò cum sit motus satellitit in orbitâ suâ revolventis ad motum apfidis ut  $\frac{360^{\circ}}{1-e}$  ad  $\frac{360^{\circ}}{1-e} - 360^{\circ}$ , hoc est, ut 1 ad  $e$ , erit motus apfidis tempore revolutionis satellitit ad fidera æqualis  $360^{\circ} \times e$ , et hic motus apfidis erit ad ejusdem motum tempore alio quovis dato ut tempus periodicum satellitit ad tempus datum. Est autem in hac nostrâ propositione  $e = \frac{3bc}{5l^2} \times 1 - \frac{3m^2}{2}$ ; unde datur motus apfidum quæsitus. Q. E. I.

#### COROLL.

Si ad lunam referatur hæc determinatio, habebuntur  $b = 1$ ,  $l = 60$ ,  $m = \sin$ ui anguli  $23^{\circ} 28' \frac{1}{2}$ , et si fuerit  $c = \frac{1}{229}$ , erit  $e = \frac{1}{1803203}$ , atque motus apogæi lunæ spatio centum annorum æqualis  $16'$  proximè, in consèquentia; si fuerit  $c = \frac{1}{177}$ , erit  $e = \frac{1}{1903142}$ , et motus apogæi æqualis  $20'$ , 7. Hac igitur quantitate minuendus est motus medius apogæi lunæ prout

prout observationibus determinatur, ut habeatur motus ille quem generat vis solis.

Pro quarto autem Jovis satellite, erunt  $b = 1$ ,  $l = 25,299$ ,  $c = \frac{1}{13}$ ,  $m = \sin$ ui anguli  $3^\circ$ ,  $e = \frac{1}{13} \frac{9}{24,7}$ ; hincque motus apsidis spatio unius anni solaris prodit  $33'$ ,  $95$  vel ferè  $34'$  in consequentia, qui tempore annorum decem fit  $5^\circ 40'$ . Insuper autem notandum est vi solis perturbari motum satellitis simili modo quo perturbatur motus lunæ; ideoque, quoniam vis solis, quâ perturbatur motus lunæ est ad lunæ gravitatem in terram in duplicatâ ratione temporis periodici lunæ circa terram ad tempus periodicum terræ circa solem, hoc est, ut 1 ad 178,725; pariter vis solis, qua perturbatur motus satellitis Jovialis, est ad ipsius satellitis gravitatem in Jovem in duplicatâ ratione temporum periodicorum satellitis circa Jovem et Jovis circa solem, hoc est, ut 1 ad 6,394,6: vires igitur, quibus perturbantur motus lunæ et satellitis, sunt ad se invicem, relativè ad eorum gravitates in planetas suos primarios ut  $\frac{1}{178,725}$  ad  $\frac{1}{6,394,6}$  sive ut 37,708 ad 1. Unde cum viribus similibus proportionales sunt motus his viribus dato tempore geniti, si vis prior vel ejusdem vis pars quælibet motum apsidis generat æqualem  $40^\circ 40'\frac{1}{2}$  in orbe lunari annuatim, vis posterior vel ejusdem pars similis et proportionalis motum apsidis eodem tempore generabit æqualem  $6'\frac{1}{2}$  in orbe satellitis, atque decem annorum spatio  $1^\circ 5'$  in consequentia. Addatur  $1^\circ 5'$  ad  $5^\circ 40'$ , et motus apsidum totus in orbe satellitis extimi Jovialis ex duabus prædictis causis oriundus spatio decem annorum erit  $6^\circ 45'$  in consequentia. Observationibus Astronomicis collegit Ill. *Bradleius* hunc motum tempore prædicto esse quasi  $6^\circ$ ; differentia illa qualiscumque

liscumque 45' inter motum observatum et computatum actionibus satellitum interiorum debet ascribi.

### SCHOLIUM.

Ex præcedentibus colligere licet motuum lunarium inæqualitates originem suam omnem non ducere ex vi solis, sed eorum partem aliquam deberi actioni Telluris quatenus induitur figurâ sphæroidicâ. Sufficiat hîc illarum computasse valorem, et legem, quæ generantur, demonstrasse: utrum autem hujusmodi correctiones tales sint ut tabulis Astronomicis inscribi mereantur, dijudicent Astronomi.

Item manifestum est præter inæqualitates eas, quæ in motibus satellitum Jovialium ex vi solis et actionibus satellitum in se invicem nascuntur, oriri alias ex figurâ Jovis sphæroidicâ ita notabiles ut Observationes Astronomicas continuò afficere debeant.

### *De Variatione motûs Terræ diurni.*

Si terra globus esset omninò sphæricus quicumque foret revolutionis axis, manente eâdem in globo motûs quantitate, eadem maneret rotationis velocitas: secus autem est, ubi ob vires solis et lunæ terra induit formam sphæroidis oblongæ per aquarum ascensum. Hîc enim non considero figuram telluris oblatam ob materiæ in æquatore redundantiam, sed sphæricam suppono nisi quatenus per aquarum elevationem et depressionem in sphæroidicam mutatur. Jam verò in sphæroide hujusmodi, quamvis eadem maneat motûs quantitas, mutatâ inclinatione axis, transversî ad axem revolutionis, mutabitur revolutionis velocitas, uti satis manifestum est: cum autem axis

trans-

transversus transit semper per solem vel lunam, singulis momentis mutabit situm suum respectu axis revolutionis ob motum quo hi duo planetæ recedunt ab æquatore terrestri et ad eum vicissim accedunt.

PROBLEMA.

*Variationem motûs terræ diurni ex prædictâ causâ oriundam investigare.*

Exhibeat sphærois oblonga  $ADCd$  (*Fig. 7.*) terram fluidam, cujus centrum  $T$ ,  $AC$  axis transversus jungens centra terræ et solis vel lunæ,  $Dd$  axis minor,  $EO$  diameter æquatoris, et  $XZ$  axis motûs diurni. Centro  $T$  et radio  $TD$  describatur circulus  $Bd$  fecans axem transversum  $AC$  in  $B$ , et agatur  $BK$  perpendicularis in  $TE$ : tum ex quovis circuli puncto  $P$  ductâ  $PM$  ad axem  $XZ$  normali quæ secet  $TA$  in  $H$ , sit  $Ppr$  circumferentia circuli quam punctum  $P$  rotatione suâ diurnâ describit, ad cujus quodvis punctum  $p$  ducatur  $Tp$  et producatnr donec occurrat superfici ei sphæroidis in  $q$ ; deinde demissâ  $pG$  perpendiculari in  $PM$ , et  $GF$  perpendiculari in  $TA$ , si per puncta  $AqC$  transire intelligatur ellipsis ellipsi  $ADC$  similis et æqualis, erit ex naturâ curvæ, quia sphærois nostra parùm admodùm differt à sphærâ,  $pq = AB \times \frac{TF^2}{TP^2}$  quamproximé. Jam designet  $U$  velocitatem particulæ in terræ æquatore revolventis motu diurno circum axem  $XZ$  ad distantiam semidiametri  $TP$ , eritque  $\frac{U \times PM}{TP}$  velocitas particulæ  $P$  circum  $Ppr$  describens, et cum sit  $TF = \frac{GM - HM \times TK}{TP} + TH$ , erit  
motus

motus totius lineolæ  $pq$  æqualis  $pq \times \frac{U \times PM}{TP} =$   
 $\frac{U \times AB \times PM}{TP^3} \times \frac{\overline{GM} - \overline{HM} \times \overline{TK}^2}{TP} + TH$ , adeoque

summa horum motuum in circuitu circuli  $Ppr$ , hoc est,  
 motus superficiei inter circulum  $Ppr$  et sphaeroidem in  
 directione  $Tp$  contentæ, æquabitur circumferentiæ hujus  
 circuli ductæ in  $\frac{U \times AB \times PM}{TP^3} \times \frac{\overline{TK}^2 \times \overline{PM}^2}{2 TP^2} + \frac{\overline{TK}^2 \times \overline{HM}^2}{TP^2}$   
 $- \frac{2 \overline{TK} \times \overline{HM} \times \overline{TH}}{TP} + \overline{TH}^2$  five quia est  $HM \cdot TM$

::  $TK \cdot BK$ , et  $TH \cdot HM$  ::  $TP \cdot TK$ , scribendo  $D$   
 pro circumferentiâ circuli  $BDd$ , æquabitur ille motus  
 quantitati  $\frac{U \times AB \times D}{2 TP^6} \times \frac{\overline{TK}^2 \times \overline{PM}^4 + 2 \overline{BK}^2 \times \overline{TM}^2 \times \overline{PM}^2}{2}$ .

Deinde horum motuum summa in toto circuitu  
 globi collecta, hoc est, motus totius materiæ globo  
 $BDd$  incumbentis prodibit æqualis  $\frac{U \times AB \times DD}{32} \times$   
 $\frac{3 \overline{TP}^2 - \overline{BK}^2}{\overline{TP}^2}$ . Ubi planeta in plano æquatoris con-

fistit, fit  $BK = 0$ , et motus prædictus æqualis  
 $\frac{U \times 3AB \times DD}{32}$ . Motus autem globi  $QPR$  circa eum-

dem axem est (uti facile demonstratur)  $\frac{U \times TP \times DD}{16}$ ,  
 adeoque motus terræ totius fit  $\frac{U \times TP \times DD}{16} +$   
 $\frac{U \times AB \times DD}{32} \times \frac{3 \overline{TP}^2 - \overline{BK}^2}{\overline{TP}^2}$ , qui cum idem semper

manere debeat, denotet  $V$  velocitatem in superficie  
 æquatoris terrestris ubi planeta versatur in plano  
 æquatoris, eritque  $\frac{U \times TP \times DD}{16} + \frac{U \times 3AB \times DD}{32} =$



$\frac{U \times TP \times DD}{16} + \frac{U \times AB \times DD}{32} \times \frac{3TP^2 - \overline{BK}^2}{TP^2}$ ; unde  
 scribendo  $\Gamma$  pro  $TP$  quatenus est radius ad finem  
 $BK$  anguli  $BTK$ , habetur  $V \cdot U :: TP + \frac{3AB}{2} -$   
 $\frac{AB \times \overline{BK}^2}{2TP} : TP + \frac{3AB}{2}$ , indeque, quia minima est  
 altitudo  $AB$  respectu semidiametri  $TP$ ,  $U - V \cdot V ::$   
 $AB \times \overline{BK}^2 : 2TP$ , et  $U - V = V \times \frac{AB \times \overline{BK}^2}{2TP}$ : pro  
 $V$  autem patet scribi posse velocitatem angularem  
 terræ mediocrem quia ab eâ differt quàm minimè et  
 ducitur in quantitatem perexiguam  $\frac{AB \times \overline{BK}^2}{2TP}$ , et

quia tempora revolutionum terræ circa centrum suum  
 sint reciproce ut motus angulares  $U, V$ , fiet differen-  
 tia revolutionum terræ ubi planeta æquatorem tenet  
 et ubi ab æquatore distat angulo  $BTK$ , æqualis  $23^h$   
 $56'$   $\times \frac{AB \times \overline{BK}^2}{2TP}$ . Quoniam igitur est acceleratio ho-  
 raria ad motum terræ horarium mediocrem circa cen-  
 trum suum ut  $AB \times \overline{BK}^2$  ad  $2TP$  siue (quia est sinus  
 $p$  inclinationis eclipticæ ad æquatorem ad radium  $\Gamma$   
 ut sinus  $BK$  ad finem distantie planetæ ab æquinoc-  
 tio, quem finem dico  $K$ ) ut  $AB \times p^2 \times K^2$  ad  $2TP$ ;  
 adeoque acceleratio horaria rotationis terræ crescit in  
 ratione duplicatâ finis distantie planetæ à puncto  
 æquinocitii, et summa omnium illarum acceleratio-  
 num, quæ tempore transit planeta ab æquinoclio ad  
 solstitium, est ad summam totidem motuum hora-  
 riorum mediorum, hoc est, acceleratio tota eo tem-  
 pore genita est ad tempus illud ut summa quantitatum  
 omnium  $AB \times p^2 \times K^2$  in circuli quadrante ad sum-  
 mam

mam totidem  $2 TP$ , id est, quia summa omnium  $K^2$  in circuli quadrante dimidium est summæ totidem quadratorum radii, ut  $AB \times p^2$  ad  $4 TP$ . Quomobrem, si denotet  $P$  quartam partem temporis planetæ periodici circa terram, erit acceleratio tota motûs terræ circum axem suum in transitu planetæ ab æquinoctio ad solstitium genita æqualis  $\frac{AB \times P \times p^2}{4 TP}$ , atque eadem erit retardatio in transitu planetæ à solstitio ad æquinoctium. Unde sponte nascitur hoc Theorema: *Est quadratum diametri ad quadratum sinûs obliquitatis eclipticæ ut quarta pars temporis periodici solis vel lunæ ad tempus aliud; deinde, est semidiameter terræ ad differentiam semiaxium ut tempus mox inventum ad accelerationem quæsitam.*

Ascensus aquæ  $AB$  vi solis debitus est duorum pedum circiter, existente semidiametro terræ mediocri  $TP = 19615800$ , unde prodit per theorema acceleratio terræ circa centrum suum gyrantis facta quo tempore incedit sol ab æquinoctio ad solstitium, æqualis  $1'' 55^{iv}$  in partibus temporis; et si vi lunæ ascendunt aquæ ad altitudinem octo pedum, acceleratio revolutionis terræ inde orta, quo tempore luna transit ab æquatore ad declinationem suam maximam, erit  $34^{iv}$ ; et summa harum accelerationum, quæ obtinet ubi hi duo planetæ in punctis solstitialibus versantur, cum non superet duo minuta tertia temporis cum semisse five  $37$  minuta tertia gradûs, vix observabilis erit. *Q. E. I.*

Cùm igitur tantilla sit huiusmodi variatio in hypothesis sphaericitatis terræ; qualis evaderet, terrâ existente sphaeroide oblatâ, frustra quis inquireret.

CXI. *Some Observations on the History of the Norfolk Boy. By J. Wall, M. D. In a Letter to the Rev. Charles Lyttelton, LL. D. Dean of Exeter.*

S I R,

Read Dec. 14,  
1758.

THE history of the Norfolk Boy, which, you inform me, has been communicated to the Royal Society, seems to deserve a place in the memoirs of that illustrious body, as well on account of its utility, as its singularity.

The symptoms in this case most evidently arose from worms in the intestines; which often occasion unaccountable complaints, and frequently elude the most powerful medicines, as they did in the instance before us, till at last they were dislodged by the enormous quantity of oil-paint, which the poor boy devoured; and the cause being thus removed, all the effects ceased.

At first sight it appears wonderful, that this immense quantity of white lead did not prove fatal; and that it was not so, could be owing to nothing but the oil, by which it was enveloped, and its contact and immediate action on the coats of the intestines thereby prevented. But the oil did not only obviate the dangerous effects of this mixture, but appears, to me at least, to have been the chief cause of the success, with which it was happily attended. I speak this with some restriction, because the lead, as its stypticity was thus covered, might, by its weight, assist in removing

removing the verminous filth, especially as the bowels were made slippery by the oil.

Oil has long been observed to be noxious to insects of all kinds, so that not only those, which survive after being cut into several pieces, but those also, which live long with very little air, and those, which revive by warmth after submersion in water, die irrecoverably, if they are immersed in, or covered with oil. Rhedi and Malpighi have made many experiments to this purpose; and account for the event very rationally from the oil stopping up all the air-vessels, which in these animalcula are very numerous, and distributed almost over their whole bodies.

On this account oil has been recommended as a vermifuge both by Andry and Hoffmann, though I believe it has been seldom used in practice in that intention; or at least has not been given in quantities sufficient to answer it. Indeed Hoffmann,\* himself seems

\* Oleosis magna tribuitur efficacia, quæ maxime experimento Fr. Rhedi videtur confirmata, dum muscas et alia insecta variis liquoribus immersa in vivis permanisse refert, exceptis aliis oleo perunctis et infusis, quæ invicem mortua vitam non receperunt, licet radiis solaribus fuerint exposita. Equidem libenter concedo hæc omnia veritati esse consona, atque etiam oleosa, ut ol. oliv. rapar. et amygd. dulc. non sine fructu adhiberi: sed scire licet minime illa eo unquam scopo posse offerri, ut vermes enecent, quia admodum magna oleorum copia requireretur, si immediatè vermes per totum intestinorum volumen dispersos deberent extinguere. Multo magis oleosa in gravibus a lumbricis symptomatibus ideo censerem utilia, quia sensibiles intestinorum tunicas spasmò contractas relaxant, et mucilagine quasi obliniunt atque defendunt, ut postea acriora quædam et purgantia remedia magis secure et sine læsione exhiberi possint. Ita ego sæpius mirabili cum effectu ad vermes enecandos et symptomata lenienda ol. amygd. d. ad aliquot cochlearia, imp. ʒj, vel

seems not to lay much stress on it as an anthelmintic, recommending it only as serving to line the inside of the intestines, and to relax spasms in them; and therefore as a proper preparative to be given before any acrid purgatives are ventured on.

The medicines commonly prescribed, and most depended on, are either of a virulent and drastic nature, or such as are supposed to be able to destroy those animals by some mechanical qualities *e. g.* to cut, tear, or otherwise affect their tender bodies, and yet not have force enough to lacerate or injure the stomach or intestines. Of the former kind are the leaves and juice of helleboraster, the bark of the Indian cabbage-tree, colocintida, resin of jalap, glass of antimony, and the like; the effects of which are commonly violent and dangerous, and sometimes fatal. Of the latter class are crude mercury, and the milder preparations of that mineral, aloes and other bitters, tin filings, neutral salts, and vitriolic acids. Every one conversant in practice too well knows, how often these medicines are administered ineffectually. When I had therefore attentively considered the history of the Norfolk Boy, I determined to try the efficacy of oil in such cases, as it seemed capable of producing great effects, and yet could not be attended with any hazard or danger.

The first person, to whom it was given, with this view, was ———, a patient of our Infirmary,

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vel 3ij circa lecti introitum vel summo mane pueris præscripti sum-  
mendum, subjungendo aliquot horas post pilulas ex extracto pan-  
chymagogo Crollii, <sup>1</sup>resina jalappæ, et mercurio dulci paratas.

*Hoffmann. Supplement. ad Med. Systemat. de Infant. Morb.  
cap. 10. de Vermibus.*

who

who was judged to have worms, but had taken several approved medicines for a considerable time without success. In a consultation with the other physicians, the following form was prescribed.

R. *Ol. Oliv. lb. ss. Sp. vol. aromat. ʒij M. cap. Cockl. iii. mane et H. S.*

The volatile spirit was added here to make the oil saponaceous, and by that means more easily miscible with the juices in the stomach and *primæ viæ*. This medicine answered our expectations, and in a few days brought away several worms.

—— Lacy, a poor boy of the parish of Feckenham in this county, aged 13 years, was, as I was informed, about three or four years ago seized with convulsive fits, which gradually deprived him of his senses, and reduced him to a state of idiocy. He had taken several anthelmintics and purgatives, particularly the *Pulv. Cornachin*. but never had voided any worms, though all the symptoms seemed plainly to shew, that they were the cause of his disorder. As he greedily swallowed any thing, which was offered him, without distinction, I at first ordered him a mixture of linseed oil ʒvij *Tinct. sac.* ʒj: of which he took four large spoonfuls night and morning. He persisted in the use of this one whole week without at all nauseating it, towards the latter end of which time he voided one round worm of a great length. He now began to shew much aversion to the medicine; on which account the *Tinctur. sac.* was omitted, and he was ordered to take the oil alone in the same quantities. This he continued to do a fortnight longer, during which time he voided 60 more worms, and in  
a great

a great measure recovered the use of his reason \*. This account I had from the Apothecary, who, by my directions, supplied him with the medicines.

Soon after this I ordered the same medicine to be given to Elizabeth Abell, a poor girl in the same neighbourhood, reduced by epileptic fits to such a state of idiocy, as to eat her own excrements. It caused her to void several worms, but she did not recover her senses.

Since this time I have given the oil to several persons with good success, and therefore I cannot but recommend a further tryal of it; since it is a remedy, which may be used with safety in almost any quantity; a character, which very few of the anthelmintic medicines deserve.

It is probable, that some oils are more destructive to worms than others. Andry (*Traité de la Generation des Vers*, cap. 8) prefers nut oil, and tells us, that a human worm, voided alive, being put into that oil, died instantly; whereas another worm, voided at the same time, lived several hours in oil of sweet almonds, though in a languishing state. This difference he afterwards (*Cap. 9*) endeavours to account for, by supposing, that the oil of almonds is more porous, and consequently less able to preclude the entrance of air into the worms. And indeed there is some reason to conclude, that oils, which dry in the open air, such as nut and linseed oils, are of a closer texture, less mixed with water, and consequently more anthelmin-

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\* I have since been informed, that the boy's parents being extremely poor, the medicines were left off as soon as he began to recover; and that, upon their disuse for some time, he was again attacked with the same fits as before.

tic, than those oils, which freeze by cold, and will not dry in the open air ; \* such as those from olives or almonds. Andry tells us, that at Milan the mothers have a custom to give their children once or twice a week toasts dipt in nut oil, with a little wine, to kill the worms : and I know a lady in the country, who gives the poor children in her neighbourhood the same oil with great success.

I would recommend this remedy to be used in as large doses as the stomach will well bear : to which purpose it may be adviseable to join it either with aromatics, bitters, or essential oils, such as the case may require. Andry orders the oil to be taken fasting, assigning this for a reason, that the stomach being then most empty, it more readily embraces and stifles the worms. During this course it will be necessary, at proper intervals, to give rhubarb, mercurial or aloetic medicines.

I cannot close this paper without observing, that, from the history of the Norfolk Boy, we may learn, in similar cases, where the head is not idiopathic, never to despair absolutely of a cure, notwithstanding the disease has been of very long standing. For in this boy, though the oppression in the brain and nerves had continued many years, and had been so violent, as to deprive him not only of his intellectual faculties, but almost all his sensations ; yet were not the organs much impaired thereby, but he recovered all his senses again, as soon as the irritation and spasms

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\* \* All oils dry more readily after they have been boiled ; by which the superfluous aqueous parts are carried off. Drying oils are also made by the addition of such substances, as absorb humidities.



in the intestines, which first caused all these terrible symptoms, were removed. The same thing in a less degree was observable in the Feckenham Boy, mentioned before; and we have had two remarkable instances of the same kind at the Worcester Infirmary; where a boy and his sister, of the name of Moyses, received a perfect cure, and recovered the entire use of their senses, after having been rendered idiots (though not in so high a degree as the Norfolk Boy) for more than two years, by epileptic fits proceeding from worms.

Worcester  
Dec. 7, 1748.

J. Wall.

*P. S.* As the following history has some analogy with the subject we are now upon, I beg leave to subjoin it by way of postscript.

A young girl of the name of Lowbridge, at Ledbury, in Herefordshire, nine years old, had been long troubled with a gnawing pain at the stomach, which growing gradually more violent, I was at last called to her. About a quarter of an hour before I reached the house, she was seized with a violent vomiting, whereby she brought up an amazing number of living animals supposed, to be upwards of a thousand, together with a vast quantity of clear viscid phlegm. In shape they exactly resembled millepedes, except that some of them, being examined by a magnifying glass, appeared to have a small filament, which arose from the middle of the belly, and might probably have served to fix them to their nidus. They were of different sizes, from that of the largest millepede, to  
some

some, that were scarce perceptible; so that they appeared to have been generated at different times, and grown in the stomach. As the child was suddenly seized with this effort to vomit, she discharged her stomach on the floor of the parlour where she was sitting. The millepedes, they told me, were at first very lively, and crept briskly different ways; but they did not live long in the open air. They were lying in the slime when I came to her, so that I could not be imposed on as to the verity of the fact. After this evacuation, the child's stomach grew perfectly easy, and continued so.

CXII. *Observations upon the Corona Solis Marina Americana; The American Sea-Sun-Crown. By John Andrew Peyssonel, M.D. F.R.S. Translated from the French.*

Read Dec. 14, 1758. **I** Shall call this insect by this name, because of the resemblance it bears to the flower called *Corona Solis*; since it is, like this, open and spread.

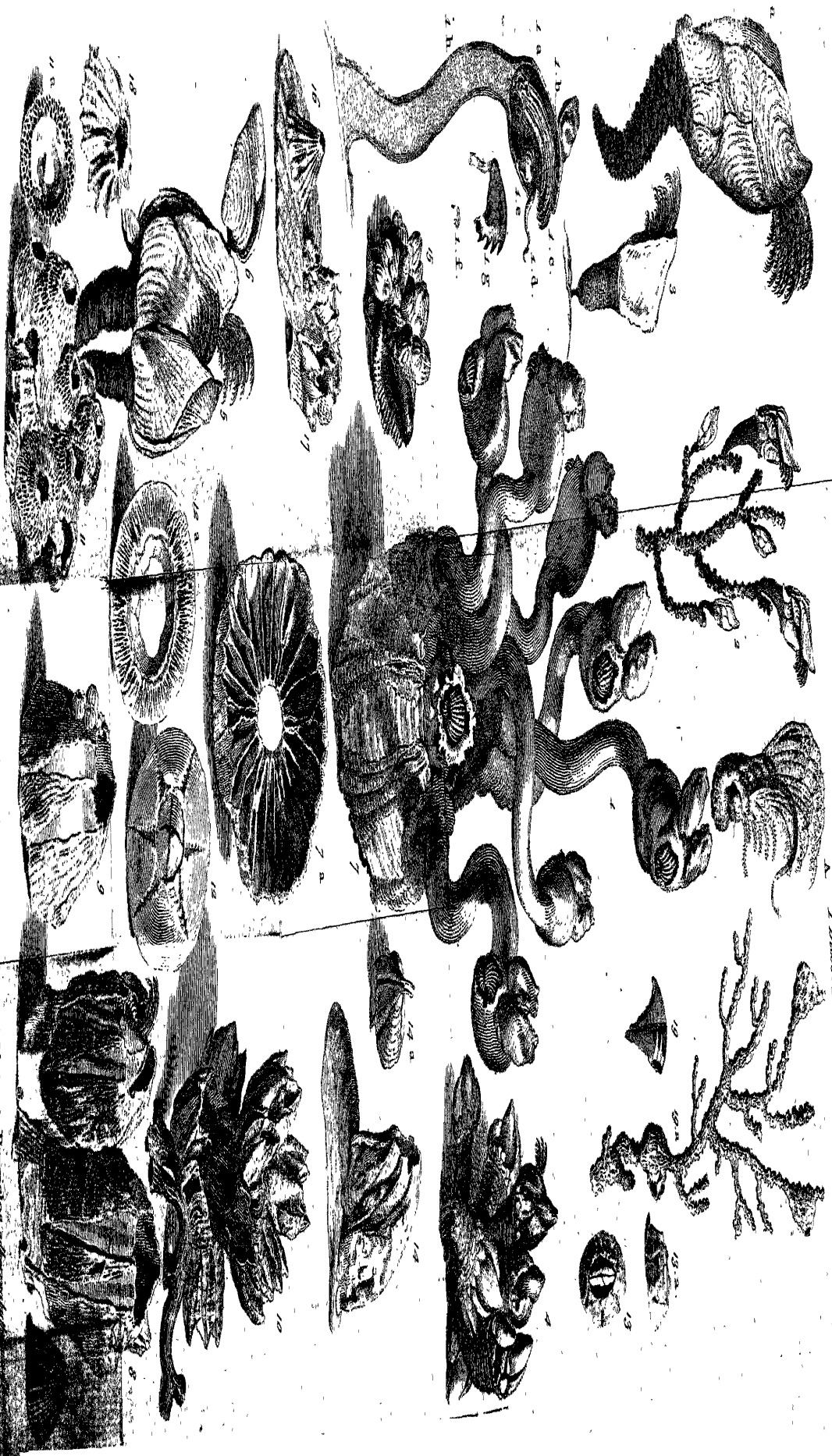
This insect adheres to the rocks by its basis, which is flat and round; and tho' this roundness is sometimes mis-shapen, it is only occasioned by the inequalities of the rocks, to which it sticks. Its diameter is about two or three inches, bearing, from the center, certain rays, like white nerves, upon a moist flesh, of a livid violet colour. These rays or nerves pass from the centre to the circumference; they, too,

consist of a soft fleshy substance, which resembles bowels or intestines ; the whole length of which is covered with glandulous bodies of a dirty grey colour ; and all these glands filled up the middle of the fish, making the flowrets, or petals, that form the disk of the flowers. There is an infinite number of these glands attached to those filets or nerves, all very distinct from one another : these filets are well ranged when viewed downwards ; but the upper part is covered by these glands, which are placed in a confused manner. These filets pass to the circumference, forming an edge full of rugosities, which leaves the body of the animal full of flaws. These hard bodies, upon which it lives, are not always permanent in the same place, but capable of changing their places from this edge or circumference ; like a skin or texture of fibres or flesh, such as the body of the sea snail I have already described ; of the same thickness, of a greenish colour, and sometimes of a greenish spotted grey, without shell, bone, or stay. The body or muscular fleshy skin raises itself up perpendicularly to three inches ; rounds itself at the top, when it is touched ; but it leaves a hole like a sphincter, formed by the reunion of the fleshy body, which enlarges itself again. The base opens to the whole extent of the bottom, makes a reversed prepuce, and immediately brings to view three rows of *papillæ*, which are of a conical figure, of one or two lines long, resembling the glands under the tongues of oxen, and which may here be compared to the demi-flowers or radiated flowers of the *Corona Solis*.

After this threefold ray of conical pointed *papillæ*, there appears a body of a livid violet colour ; I took  
it







Lepidopoda Pedatae

Form

with Horns

Lepidopoda Sefales

Radum dictas

Humiditas

1. *Leptopoda pedata* (Linn.)  
2. *Leptopoda pedata* (Linn.)  
3. *Leptopoda pedata* (Linn.)  
4. *Leptopoda pedata* (Linn.)  
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95. *Leptopoda pedata* (Linn.)  
96. *Leptopoda pedata* (Linn.)  
97. *Leptopoda pedata* (Linn.)  
98. *Leptopoda pedata* (Linn.)  
99. *Leptopoda pedata* (Linn.)  
100. *Leptopoda pedata* (Linn.)



it for a particular substance or body ; but having examined it, I observed it was only a pellicle, or membrane, that covered a part of the *papillæ* I mentioned. This membrane has sixteen separations, which form kinds of purses, and yet leave, in the center of the animal, an empty space, wherein several glands are brought in view. I do not know, whether, in the natural state, these membranes do not retire to the circumference, in order to discover the glands within, which they usually hide, and which fill up all the middle of the crown ; but when the fleshy body is gone up again, it covers all the interior parts, closes them in, and preserves them from the touch of any extraneous body. I cannot tell how these fishes live, or what is their mechanism ; for I could not distinguish either a mouth, or any *viscera*, nor any other organ serving to their nourishment.

CXIII. *An Account of several rare Species of Barnacles. In a Letter to Mr. Isaac Romilly, F. R. S. from John Ellis, Esq; F. R. S.*

Dear Sir,

London, Dec. 21. 1758.

Read Dec. 21, 1758. **T**HOSE rare and very extraordinary new species of Barnacles, which you have lately received from abroad, are so different from any of the common species, that I have seen, that I was resolved to inquire into the nature of an animal, which, like a Proteus, appears in so many different



different shapes or coverings in different parts of the world. For this end I have consulted that excellent collection in the British Museum, and some others in the cabinets of my curious friends.

In this inquiry I met with some very rare ones, which have not yet been described, as you will observe in the annexed plate [See TAB. XXXIV.], where I have given exact drawings of yours, as well as the other species of this genus.

This marine animal is called, by writers on natural history, *Balanus*, and *Concha Anatifera*: but the celebrated Professor at Upsal, Dr. Linnæus, calls the internal active part, or fish, the Animal Triton, and the covering or testaceous habitation *Lepas*, which he says is a multivalved shell, composed of unequal valves. The Animal Triton he describes, as having an oblong body, a mouth with a tongue in it, twisted about in a spiral manner; sixteen tentacula or claws: six of the hinder ones on each side, he says, are cheliferous.

This account differing from that given by the ingenious Mr. Turberville Needham, F.R.S. in his *Microscopical Essays*, I shall give the character of this animal, as it appeared to me from the many observations I made on it, while alive in salt water; and these I compared not only with many dried specimens of other varieties, but likewise with some of yours, that were preserved in spirits; and I found that the parts of the animal agree in all the species.

The experiments, that I made, were on the common English Barnacle, which is very frequently met with, at this time of the year, on oysters and other shell-fish. The microscope, that I made use of to observe

observe it, was Mr. Cuff's aquatic one; where the animal, when taken out of the shell, may be put into the watch-glass with salt water, or spread on the round glass plate on the stage of the microscope, and kept moist with a hair pencil and salt water during the time of observation: this will keep the claws and proboscis alive and in motion for many hours together.

This animal has 24 claws, or cirrhi (*See Fig. A*), which are disposed in the following manner: the 12 longest stand erect, arising from the back part of the animal: they are all joined in pairs near the bottom, and inserted in one common base. These appear like so many yellow curled feathers: they are clear, horny, and articulated. Every joint is furnished with two rows of hairs on the concave side. The animal, in order to catch its prey, is continually extending and contracting these arched hairy claws, which serve it for a net.

The 12 smallest claws are placed next to these, six on each side: these are divided into pairs; that is, two claws to one stem, like the chelæ or claws of the crab. These are more pliable, and fuller of hairs, than the others, and seem to do the office of hands for the animal.

The whole number of claws lessen in size gradually each way, from the tallest in the back, to the last but one of each side in the front; which last two are of the middle size.

The proboscis, or trunk, rises from the middle of the base of the larger claws, and is longer than any of them: this the animal moves about in any direction with great agility: it is of a tubular figure,  
trans-

transparent, composed of rings lessening gradually to the extremity, where it is surrounded with a circle of small bristles, which likewise are moveable at the will of the animal. These, with other small hairs on the trunk, disappear when it dies.

Along the inside of this transparent proboscis the spiral dark-coloured tongue appears very plain: this the animal contracts and extends at pleasure.

The mouth appears like that of a contracted purse, and is placed in front, between the fore claws. In the folds of this membranous substance are six or eight horny laminæ or teeth standing erect, each having a tendon proper to direct its motion. Some of these teeth are serrated, others have tufts of sharp hairs instead of indentations on the convex side, that point down into the mouth; so that no animalcule that becomes their prey can escape back.

Under the mouth lie the stomach, intestines, and the tendons by which they adhere to the shell.

This then is the general character of the animal of the whole genus, whether with stems or without.

I shall now give you a short description of the several kinds I have met with, besides those of your own, and shall divide them into two kinds; those that have stems, and those that adhere by their shelly bases.

The first and most remarkable of those that have stems is the Barnacle, *Fig. 1.* This differs from the *Lepas* of Linnæus in not having a testaceous, only a cartilaginous or fleshy covering. On the top of it are two erect tubular figures like ears: these have a communication with the internal parts of the animal (*See Fig. 1. b.*). These inner parts agree with the  
general

general character already given. The stem, which is here dissected, was full of a soft spongy yellow substance, which appeared, when magnified, to consist of regular oval figures, connected together by many small fibres, and no doubt are the spawn of the animal.

This extraordinary animal (of which there were seven together) was found sticking to the Whale Barnacle (*See fig. 1. & 7.*), by Mr. Smith of Stavenger in Norway, who cut both kinds together off a whale's lip, that was thrown upon that coast last year, 1757, and immediately immersed them in spirits of wine; by which means we have been able more exactly to describe them.

I have called this animal the Naked Fleishy Barnacle with Ears; but it appears to claim the name of Triton rather than Lepas, according to Linnæus, as having no shelly habitation.

*Fig. 2.* is the next animal of this class: this is not yet described. I found several of them sticking to the Warted Norway Sea Fan, which Dr. Pantoppi-dan, the Bishop of North Bergen, sent you: from its appearance, I have called it the Norway Sea Fan Penknife. The stem of this is covered with little testaceous scales. The upper part of the animal is inclosed in thirteen distinct shells, six on each side, besides the hinge-shell at the back, which is common to both sides: these are connected together by a membrane that lines the whole inside. One of these is magnified a little at *fig. 2. a.*, in order to express the figure and situation of each shell the better.

*Fig. 3.* is taken from D'Argentville's *Lithologie*, *Pl. 30. fig. H.*, who says it is found in the British channel

channel sticking to sea plants; and that these shells consist of five pieces. This, from its appearance, I have called the British Channel Penknife, to distinguish it from the other.

*Fig. 4.* is a species of Barnacle called Pouffepieds by the French, and described by Rondeletius as commonly found adhering to rocks on the coast of Brittany. He says the people there boil and eat the stem, which is first of a mouse-colour, and afterwards becomes red like our prawns. There are many heads, that arise out of one stem, each of which consists of two shells, in which are the same parts of the animal as in the other species. This I have called the Cornucopia Barnacle. Some of the shells of this Barnacle were drawn from a specimen in the British Museum. This *Lepas* is the *Mitella* of Linnæus.

*Fig. 5. and 6.* are the Barnacles called *Conchæ Anatiferæ*: these are the sorts so well known to sailors, and formerly supposed to produce a large species of duck called a Barnacle. These consist of five shells. The tube, that supports one of these kinds, branches out like some species of corallines, bearing a shelled animal at the end of each branch. They are generally found adhering to pieces of wood in the sea, and most ships have some of them sticking to their bottoms. Those of the southern and warmer climates are generally of a larger kind than those of the colder and more northern climates.

The next division of these animals is, those that adhere by the base of their shells, having no stems.

Here I must observe, that the bottoms of the several species of this division conform in shape to the substances they adhere to, or grasp them in such a peculiar

peculiar manner, as to render their situation secure from the violence of the element they live in. Another provision of nature for the security of these animals are the four opercula, which, upon their retreating into the great shell, they can draw to so close after them, as to secure themselves from outward danger.

*Fig. 7.* represents the Whale Barnacle, called *Pediculus Ceti*, just as it was cut off the whale's lip, with the seven naked Barnacles with ears, already described. *Fig. 7. a* is the bottom of the shell. This has the appearance of the gills of a mushroom. All the spaces between these laminæ were filled with the blubber of the whale: by this means they adhere to the gristly skin of the fish. The narrow cavities between the branched laminæ are the places where the ligaments or tendons, that move the opercula, are inserted.

*Fig. 8.* is the Cup Barnacle, taken off an East India ship from Sumatra. The testaceous flat bottom of this was marked with the seams and lines of the sheathing, and with the rust of the nails. In one of these shells the animal is represented protruding his claws thro' the opercula.

*Fig. 9.* is called the Bell-shaped Barnacle. This was taken off the bottom of a ship from Jamaica, and had its flat testaceous base marked as the former.

*Fig. 10.* This represents part of a most elegant specimen in the curious collection of Dr. John Fothergill. It is called the Tulip Barnacle, and very properly, as well from the shape of its shell, as the beautiful stripes of red mixt with white. It adheres to a piece of the true red coral, and was fished up

near Leghorn, on the coast of Italy. It is not improbable, but that these groups of Barnacles, growing at the same time with the animals that formed the red coral, may have received an addition to their fine red colour from the coral.

*Fig. 11.* is a group of Barnacles of a conical form, composed of purplish tubes like small quills. *Fig. 11. a* represents one of the same, with a view of its base, from the collection of Mr. Peter Collinson, F. R. S. This was brought from the East Indies. The insides of these shells have the appearance of the spongy parts of bones.

*Fig. 12.* is called the Tortoise-wart Barnacle, being often found upon that animal. This shell is of a plano-convex shape, and looks like polished ivory. The divisions between the valves represent a star with six points. If these shells are put into soap lees, they will in a few hours separate into six pieces or valves, each shelly valve having two ears, like the scallop-shell: so that this species has its valves connected by membranes, instead of testaceous sutures, as most of the others have. *Fig. 12. a* represents the under part of the same shell.

*Fig. 13.* This shell is marked with six rays like a star, as the former; but is much deeper in proportion to its diameter. Several of this kind were found sticking to a crab, that was lately brought from the island of Nevis; from whence I have called it the American Crabs-wart.

*Fig. 14.* is called the Side-mouth Barnacle. This was found on the southern coast of Africa, near the Cape of Good Hope, where it adheres to a particular species of striated purple muscle. *Fig. 14. a* represents

sents two of the opercula of this Barnacle remarkably horned. The shell of this is very thin; but its obliquity may probably be owing to its situation.

*Fig. 15.* This egg-shaped Barnacle with a small mouth is found in clusters sticking to the Buccinum tribe of shells in the West Indies.

*Fig. 16.* is the Cornish Barnacle, shaped like a cone, and with a small mouth. This is described and figured by the Rev<sup>d</sup>. Mr. William Borlase, F.R.S. in his Natural History of Cornwall, lately published.

*Fig. 17.* This is the common English Barnacle, that is found in such plenty upon all rocks and shells round this island. From the animal of this, examined in the microscope, I have taken the character of the fish of the Barnacle genus.

*Fig. 18.* This I have called the Limpet-shaped Barnacle, from its likeness to some species of that shell. I am indebted to our late worthy member, Mr. Arthur Pond, for this shell, who assured me it was brought to him from Greenland. It was, with several more, found sticking to a very large species of muscle.

*Fig. 19. a.* This Sea-Fan, with the Barnacles inclosed in it, was brought from Gibraltar. I have called it the Slipper Barnacle, from its shape. *See Fig. 19.* These shell-fish adhere, while they are young, to the slender branches, which are produced by the animals that compose this species of Sea-fan; and as the next succession of young animals of this sea-fan creep up its sides, to increase the bulk and extension of these first-formed ramifications, they inclose the shells all round, leaving only their mouths or apertures open, for the Barnacles to procure their  
food.



food. But it frequently happens, that the animals of the Sea-fans destroy these Barnacles, by overrunning and involving them in the very center of their stems. These small Barnacles, interspersed here and there on the branches, have been taken for fruit or berries by some gentlemen, who look upon the internal or horny part of the Sea-fans to be vegetables.

*Fig. 20.* is a very curious Barnacle, taken from an elegant specimen in the British Museum; which, from its figure, I have called the Persian Crown.

I shall now add some further observations on the nature of these animals.

Upon opening the shells of many of the common English Barnacles (*Fig. 1.*) while they were alive, I found the lower part of the shell, which contained a cavity equal to two thirds of the whole, full of spawn; so that the Barnacles, which adhere by the base of their shells, as well as those that are supported by fleshy tubes, are propagated by eggs, which they send forth in inconceivable numbers; as appears by the clusters of young shells, which we find adhering not only to the parent animals, but to all hard substances near them.

The bottom shell of these animals, as well as their upper shells, vary in form according to their situation, which occasions some difficulty in determining their several species with exactness. The form of the base shell of our common English Barnacle, is the flat radiated figure represented adhering to a scallop shell in the front of a group of them at *Fig. 17.* The Barnacles at *Fig. 8, 9, 14, 15.* and *20.* have the same kind of base.

I have very lately observed a singular kind of flat Balanus, on a white Mandreporea coral from the coast of Italy, in the possession of Mr. Mendez D'Acosta, F.R.S. whose base appears sunk into the coral, and of the form of an inverted cone, bending a little to one side. The inward surface of this conical base shell appears curiously striated with tubular radii, which terminate on the surface of the coral, to receive the extremities of the six valves, that compose the upper shell. This peculiar form of the base seems owing to the animals of the coral and of the Barnacle growing up together, the latter keeping possession of its proper space, while the former grew close about it.

The bottom shell of the Barnacle like a Limpet, at *Fig. 18.* increases from a small point by many thin shelly margins, which exactly correspond to the indentations which we observe on the base of the outward shell; so that it appears not unlike the drawing of a fortification in miniature.

I am,

Dear Sir,

Your most affectionate Friend,

John Ellis.

P. S. The Rev. Mr. William Borlase is now of opinion, that the Cornish Barnacle at *Fig. 16.* which he has described in his History of Cornwall, is rather a Limpet or Patella.

CXIV. *A further Account of the poisonous Effects of the Oenanthe Aquatica Succo viroso crocante of Lobel, or Hemlock Dropwort, by W. Watson, M.D. F.R.S.*

To the ROYAL SOCIETY.

Gentlemen,

Read Dec. 21, 1758. **I**N the month of June 1746. I communicated to you some observations concerning the *Oenanthe aquatica Succo viroso crocante* of Lobel, in relation to its poisonous effects upon some French prisoners at Pembroke. These observations were afterwards published in the *Philosophical Transactions* \*, with an accurate representation of the plant itself, from an original drawing by that compleat artist Mr. Ehret. This at that time I thought the more necessary, as it was of no small importance to the public, to be well acquainted with a plant, the effects of which, when taken into our bodies, were so much to be dreaded. This account of mine, as well as the representation of the plant, were republished from the *Transactions* into the periodical works of that time; from whence a more extensive knowlege of and acquaintance with this plant might have been hoped for. A late instance however has evinced, that these endeavours have not had their full effect, as the plant in question is not yet sufficiently known, and attended to.

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\* See Phil. Transf. N°. 480. p. 227.

John Midlane, a cabinet-maker of Havant in Hampshire, aged about 58, and of a gross habit of body, was advised to make use of the water parsnep, as a remedy for a severe scorbutic disorder, which he had long been troubled with; and for which he had taken a variety of medicines. Instead of the water parsnep, which he purposed to take, there were gathered for him some roots of the *oenanthe* above mentioned; a large one of which was pounded in a mortar, and the juice thereof squeezed through a linen cloth, and amounted to about five spoonfuls. This was suffered to stand all night, and the next morning (Mar. 31. 1758.), at about half an hour past five, he drank the whole quantity, except the sediment.

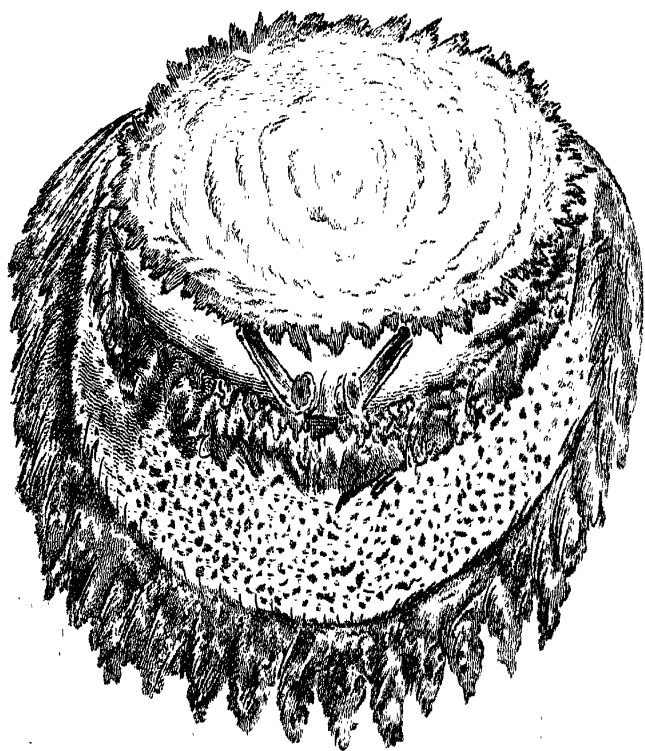
In about an hour and half after he had taken this juice, he walked about the town upon some business; and a little before seven, upon his return home, about an hundred yards from his own house, he first complained that he was ill; and having walked about thirty yards further, was so bad as to go into a neighbour's house to rest himself. He was soon led from thence to his own house by two men, and told them, that he was affected as though he had lost the use of his limbs. When he was placed in his chair, he complained greatly of pain all over him; but particularly in his head. His stomach was immediately after affected, and he had great reachings to vomit. At the second attempt he threw up about half a pint of a clear watry liquor; at the first and third attempt he discharged scarce any thing. He was then seized with a great propensity to go to stool, which went off in about three minutes. After this,

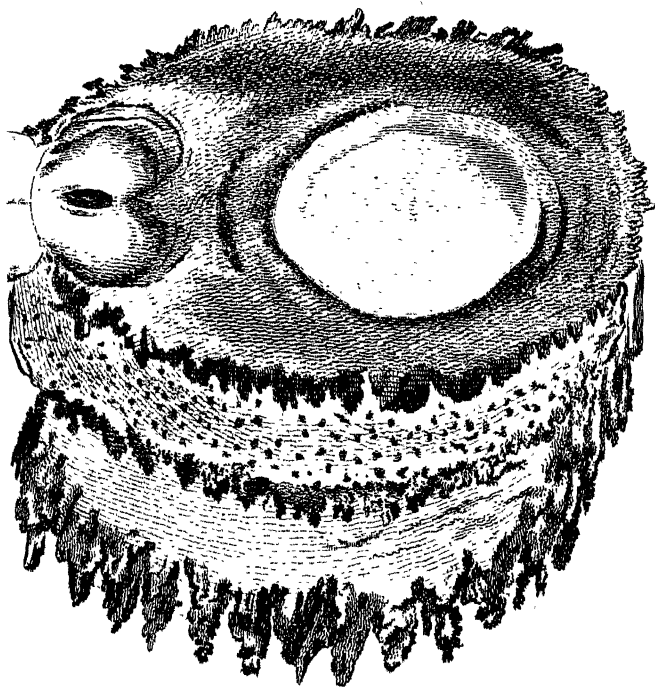
he with the greatest difficulty was conducted up stairs to bed, where he pulled off part of his cloaths himself. When he was put to bed, he was attacked with very severe convulsions, which in about a quarter of an hour deprived him of his senses; and continued, with a few intermissions, till he died, a little before nine o'clock; which was about three hours and half after the juice had been taken. A profuse sweat accompanied the whole of these symptoms: he foamed considerably at the mouth, and his belly swelled greatly. He purged very much soon after he was dead, but not before.

As this poor man had taken this dose before his family were up, no one could imagine from whence his disorder arose; and consequently the apothecary, who was called to him, was able to form a judgment of his case only from the symptoms; as on his coming he found his patient senseless, and who had not, while his mind was undisturbed, told any one the probable cause of his complaints. He took from him however about ten ounces of blood, and endeavoured to get some *vinum ipecacuanhæ* into his mouth: but his jaws were closed so fast, not above a spoonful passed, and that by the accident of his mouth opening of itself.

The symptoms, with which the person above-mentioned was attacked, were much the same as those which were observed in the French prisoners, who were poisoned by the same root at Pembroke. In both instances occurred those severe muscular spasms, which kept the under jaw so close to the upper, that, while the spasm continued, scarce any force could separate them. In both instances like-  
wise







*J. Mynde sc.*





wife a considerable time passed before the persons, who had eaten of this root, though they had taken enough of it to destroy them, perceived themselves disordered by it.

I am obliged for this communication to Richard Warner, Esq; of Woodford, a gentleman of great merit, whose zeal for the promotion of useful knowledge I have many times experienced.

The expediency of laying before you observations of this sort, which may tend, by making people careful of what they take, to the saving the lives of many, makes no apology necessary for so doing. I am, with all possible regard,

Gentlemen,

Your most obedient humble Servant,

Lincoln's-Inn-Fields,  
20 Dec. 1758.

W. Watfon.

*CXV. Extract of a Letter to John Eaton Dodsworth, Esq; from Dr. George Forbes of Bermuda, relating to the Patella, or Limpet Fish, found there.*

2 April, 1758.

Read Dec. 21,  
1758.

**A**S a curiosity for your esteemed friend Mr. Theobald, the Captain will deliver you two fishes, intirely singular here, and never before observed amongst us. The one is of the shell kind, and changed its figure so often, that it was difficult to make a drawing. However

I got a young man to take it in two different positions, and have sent the drawings with the fish. See TAB. XXXV.<sup>1</sup>

The small one may be called the sea-batt; and in some sort resembles that species of animals when it is swimming.

*Additional Remark by Charles Morton, M.D. F.R.S.*

The Patella, or Limpet Fish, whose generic characters, as enumerated by Bishop Wilkins, are, that it is an exanguious testaceous animal, not turbinated; an univalve, or having but one shell; being unmoved; sticking fast to rocks or other things; the convexity of whose shell doth somewhat resemble a short obtuse-angled cone, having no hole on the top.

CXVI. *A Discourse on the Cinnamon, Cassia, or Canella.* By Taylor White, Esquire, F. R. S.

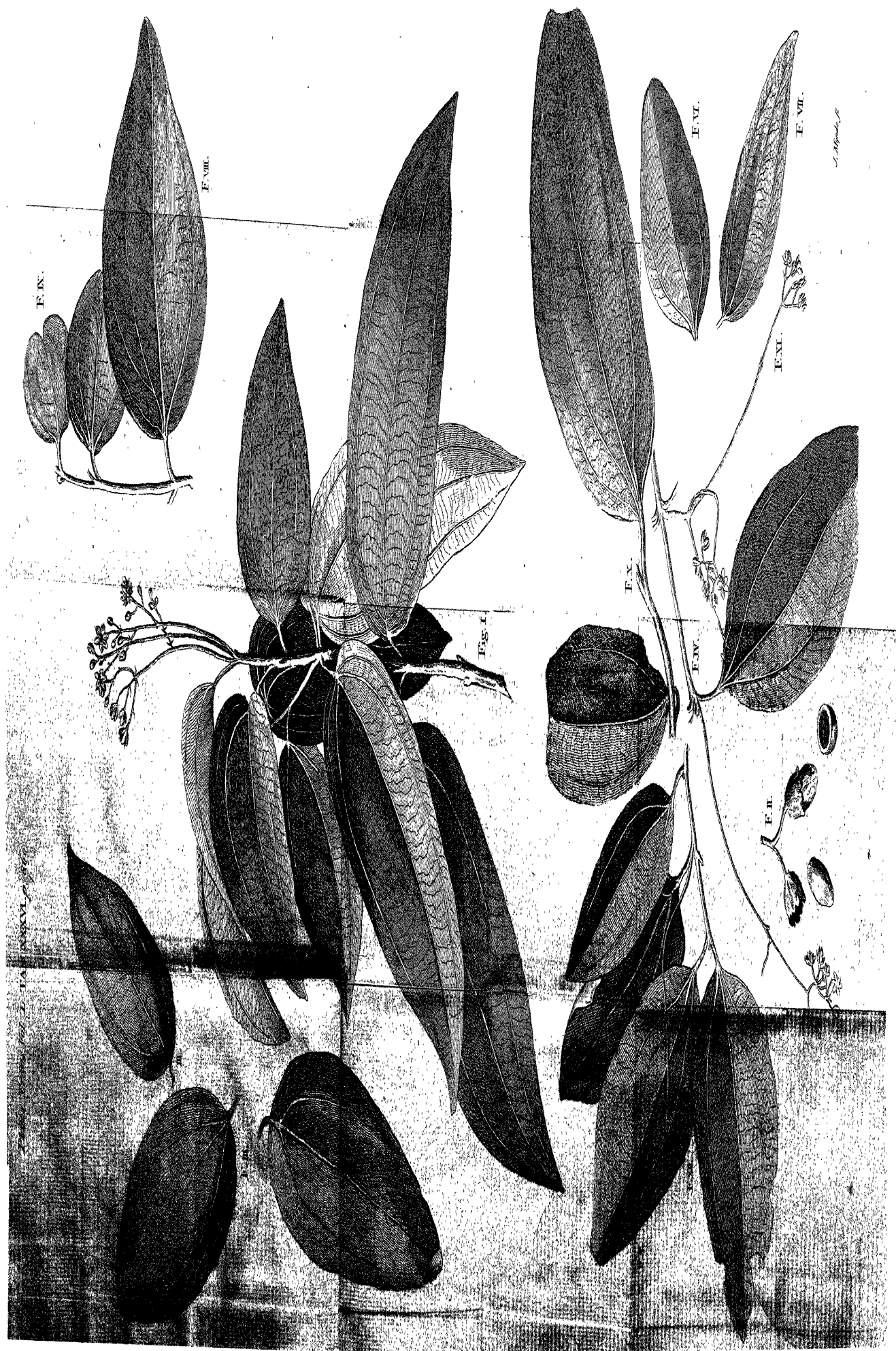
Read Dec. 21, 1758. **T**HE Cinnamon, Cassia, or Canella, are shrubs of no great height: they grow in Ceylon, Malabar, Java, Sumatra, and other places in the East Indies; as I think, in the island of St. Thomas, and on the coast of Coromandel.

They are described by Mr. Ray, in his *History of Plants*, vol. ii. f. 1559. under the title *de Arboribus Pruniferis*.

Linnaeus,









Linnæus, in his *Species Plantarum*, places them under the title *Enneandria Monogynia*, by the name *Laurus*.

The leaf, flower, and fruit, of this plant, are particularly described by Mr. Ray.

The leaf is smooth and shining; has one large vein running thro' the midst, and a remarkable one on each side; the middle one generally running near the length of the leaf.

The leaves differ in shape, some being more acute, others more oval or obtuse.

The flowers grow in an umbel, somewhat like the *Laurus Tinus*; but they are small, consisting of one petal, of a tubular form at the bottom, and divided at the top into six segments in the form of a star.

The flowers are succeeded by berries growing out of a capsula, like acorns in shape; which berries contain a shining seed.

The description of Mr. Ray of the flower, in his description of the Cinnamon of Malabar, is extremely accurate; as is also the figure in the *Hortus Malabaricus*, N<sup>o</sup>. 54. and the description, fol. 107. under the name *Carua*. I shall therefore refer to those.

I shall not trouble you with the question debated by Mr. Ray, whether the Cinnamon and Cassia of the ancients were, or were not, the same with those so called by the moderns? whether the Cinnamon of the ancients was the twigs of the tree bearing cloves, or any plant now unknown to us? Mr. Ray has largely treated on this subject; and to him I refer such as are curious to be informed on this subject.

But as the Cinnamon and Cassia of the ancients are said to have been used as perfumes, and to make  
perfumed



perfumed ointments, I think they must have differed from ours, whose smell is not very fragrant, nor is emitted to any great distance.

The matter of the present inquiry is, whether the Cinnamon of Ceylon is the same sort of plant with that growing in Malabar, Sumatra, &c. differing only by the soil or climate, in which it grows, which is the opinion of Garcias; or from the culture or manner of curing the plant, as I am inclined to believe; or whether it is really a different genus or species of plant, as many people believe, and some botanical writers seem to indicate.

I shall endeavour to explain this matter by producing, 1st, The descriptions of the most celebrated authors:

2dly, By producing the most accurate figures of the plants of Sumatra and Ceylon: [See Tab. xxxvi.]

3dly, By shewing the specimen of the leaves and branches brought from Sumatra.

I have no specimen from Ceylon; but have carefully examined the specimens kept in the British Museum, with the assistance of Dr. Maty and Mr Empson, and compared them with the specimens I have from Sumatra; from whence I traced exactly the figures brought herewith: which specimens are undoubtedly brought from Ceylon, and were the collections of Boerhaave, Courteen, Plukenet, and Pottiver.

But, previous to this inquiry, I would premise, that the writers, who give the description of the Cinnamon of Ceylon, were probably not acquainted with that of Malabar at the time of their publishing their works.

Mr.

Mr. Ray also, who so accurately describes the flower of the Cinnamon of Malabar, seems not so well acquainted with its fruit; and probably had then never seen the specimens of the Cinnamon from Ceylon; for his description is plainly borrowed from others, and not his own. Tho' I have reason to think he afterwards saw the specimens of Mr. Courteen, and was convinced, that the plants were the same.

In his description of the Cinnamon of Ceylon, he supposes differences in the manner of veining the leaf, which are not found in the leaves themselves. He supposes, that the Cinnamon of Ceylon differs from that of Malabar by its berries growing in cups like acorns; which is apparently the same in both, as may be seen in its figure in the *Hortus Malabarius*.

The other differences taken notice of by the botanic writers are as follow :

In the *Flora Zeylanica*, p. 545. and in the *Materia Medica*, 190. the Cinnamon of Ceylon is called *Laurus foliis trinerviis ovato-oblongis nervis unientibus*: which description is adhered to in the *Hortus Cliffordienfis*, p. 154. under the name *Laurus foliis oblongo-ovatis nitidis planis*. And Burman, in his *Flora Zeylanica*, 62. T. 27. calls it *Cinamomum foliis latis ovatis*. Whereas the Cassia of Sumatra is distinguished by these writers: that in *Flora Zeyl.* 146. and in *Materia Medica*, 191. is called *Laurus foliis trinerviis lanceolatis nervis supra basin unitis*: and Burman, *Zeylan.* 63. T. 28. calls it *Cinamomum perpetuo florens folio tenuiore acuto*.

The distinction therefore, which these writers would make us believe there is between these plants, consists  
in

in the leaves of the one being oval, the other sharp-pointed; and that the nerves are limited at the bottom in the Cinnamon, but not so in the Cassia: for as to the *semper florens*, mentioned by Burman, that must undoubtedly be common to both.

Now as to the different shape of the leaves, we know how often this happens by seminal varieties, and from the age of plants, as in the leaves of holly and ivy; and that even the shapes of leaves vary greatly on the very same plant, and sometimes on the same branch; as in the ash, and many other plants, the leaves of the young shoots are more oval than those on the old boughs, which are generally more pointed. But this variety is much more frequent in the plants of warm countries. In the saffra-  
fras, part of the leaves generally near the bottom of the plant are plain, whilst the other leaves are divided into three lobes or segments. I have observed great difference also in the leaves of almost every one of the American oaks.

In the Virginian cedar, the berries of the same plant produce some plants with juniper leaves, and others with leaves like the savin; and some plants with both leaves growing on the same plant.

I must observe, that Burman has, in his figures of the two plants before mentioned, made them extremely different. In that of Ceylon he has made all the leaves oval; and, to make the difference greater, has drawn the rudiments of the berries; to which he has added the flower, or part of it, at the top of the style or rudiment of the fruit: and in that of Malabar he has drawn the flower growing in the umbel.

On these drawings I must observe, that his drawing of the Cinnamon of Ceylon agrees with no one specimen in the British Museum; and scarcely is one leaf to be found of the shape, which he gives.

The first figure, which I shall produce, is a drawing, which I procured from the ingenious Mr. Ehret in the year 1754: which, as I am informed by Mr. Empson, was from a specimen, given to Mr. Ehret by him in that year, of the Cinnamon of Ceylon. *See Fig. 1.*

This agrees in every thing with the drawing of the Cinnamon of Malabar in the *Hort. Malab.* fig. 54. fol. 107. and there called Carua; except that it wants the fruit: but that defect is supplied by Mr. Ray's description of the Cinnamon of Ceylon above mentioned. *See fig. of the fruit, Fig. 2.*

In the figure in the *Hort. Malabar.* it may be observed, that the nerves do not go quite to the bottom of the leaf. But this is merely accidental, as will appear by the leaves of the same plant brought from Sumatra, which I shall produce; in which, part of the leaves have veins going quite to the bottom, and united there, and the others not so. *See Fig. 3.*

The next drawing I shall produce contains that of the leaves of the Cinnamon plant, from specimens in the British Museum.

*Fig. 4.* A specimen, with the flower, from the collection of Mr. Courteen, who lived long in Ceylon. These leaves were more pointed, but were broke at the end.

*Fig. 5.* A whole leaf, with its point, in the same collection, growing on a branch, on which are the rudiments of the fruit.

Fig. 6. A leaf in Plukenet's specimens.

Fig. 7. Another leaf of the same collection, and of the same plant.

Fig. 8. A leaf of a large specimen from Boerhaave's collection.

Fig. 9. Another leaf on the same branch.

Fig. 10. A specimen from Petiver's collection.

The points of the leaves are broken off.

Fig. 11. The flower of the first specimen.

Fig. 12. In the rudiment of the seed before formed, in the state given in Burman's first drawing.

*Note*, It is to be observed also, that the specimens of the Cinnamon of Ceylon are probably of cultivated plants.

From all these specimens it plainly appears, that the distinction of *foliis ovatis & lanceolatis* does not appear well founded.

But were it otherwise, and that the leaves of the plants differed, it would by no means be a proof of any material difference in the nature or quality of the plants; as is well known to persons conversant in natural history.

Before I leave this subject of the description of the plant, it may be proper to mention, that Bauhin calls the one of these plants *Cinnamomum* or *Canella Malabarica & Javanensis*, and the other *Cinnamomum Canella Zeylanica*, Bauhin. *pinax* 408 and 409; but neither from these names, nor from his description, can any conclusive argument be formed: and that Herman, in his *Hort. Lugd. Batav.* 129. t. 1655. calls this Cinnamon of Ceylon *Cassia Cinnamomia*.

If any conjecture can arise from hence, it may be, that the Cinnamon of Ceylon was formerly, as well

as

as that of Sumatra and Malabar, called Cassia ; but that the Dutch writers, being acquainted with the excellent qualities, which the ancients ascribed to their Cinnamon, chose to add the name Cinnamon to that of Cassia : and in process of time they have found the name of Cinnamon more profitable than that of Cassia, by which we chuse to call our Canella, to our national loss of many thousands a year.

Having now given an account of the figure of these plants, and in what respect they are said herein to differ ; I shall proceed to consider the pretended differences in the Canella itself ; which are supposed not to be in form only, but substantial and material ; and are generally understood to be so by persons supposed to be acquainted with the subject.

Mr. Ray states this matter fully in his *Hist. Plant.* vol. ii. p. 1560. in these words : *Officinæ nostræ Cassiam ligneam a Cinnamomo seu Canella distinctam faciunt, Cassiam Cinnamomo crassiorē plerumque esse, colore rubicundiorē, substantiā duriorē, solidiorē & compacterē, gustu magis glutinoso, odore quidem & sapore Cinnamomum aptius referre, tamen Cinnamomo imbecilliorum & minus vegetam esse, ex accurata observatione Tho. Johnson.*

From these reasons Mr. Ray draws a conclusion (I must own not very instructive), that the Cinnamon of Ceylon is Cinnamon ; and the Cinnamon of Malabar, &c. is the Cassia of the shops.

From the specimens I shall now produce, it will most plainly appear, that these differences are merely accidents arising from the age of the Canella, the part of the tree from whence it is gathered, and from the manner of cultivating and curing it.

In the *Philosoph. Transact.* N<sup>o</sup>. 278. p. 1099. in Mr. Strachan's account of Ceylon, which is abridged by Eames and Martyn, vol. ii. p. 183. he says, that there are two sorts of Cinnamon-trees, of which the tree, which is esteemed the best, has a leaf much larger and thicker than the other; but otherwise no difference is to be perceived.

*Note,* Here is no mention of the *folio ovato*.

I remember, in an account given some years ago to the Royal Society, three or four sorts were mentioned; and it was said the best sort was cut every three or four years.

This superiority I then guessed (as well as the difference of leaves mentioned by Mr. Strachan) to arise from the cutting the tree down every three or four years; which occasioned it to produce strong and vigorous shoots, thicker and larger leaves, as well as greater quantity of bark, and of a superior quality.

A large shoot or sucker of this plant was produced in the year 1750. or 51. by my worthy friend Dr. William Watson, together with an account of the Cinnamon-tree; which is published in the *Philosoph. Transact.* vol. xlvii. p. 301. This shoot was a plain proof to me, that the Cinnamon was frequently cut down, and that this shoot arose from the root of a plant so cut; for it was of the size of a walking-cane; and no shrub could have produced such a shoot, unless a strong plant cut down.

This method of treating this plant accounts for the mistake of Garcias, mentioned by Mr. Ray; viz. *Quæ Garcias habet de duplici hujus arboris cortice ad modum suberis, nobis suspecta sunt, quæque de de-*  
liberatione

*liberatione semel triennio facta; non enim puto renascitur cortex semel detractus.*

This shews, that the bark was gathered every three years : but Mr. Ray was not acquainted, that the plant was cut down, in order to take off the bark, once in three years.

In the account above mentioned to be given to the Society by Dr. Watson, no descriptions are given either of the plants of Ceylon, or Malabar ; but he quotes Burman, who says, that he had nine different sorts of Cinnamon from Ceylon, of which that, which is the best, is brought to us, and called by the name *Rasse Coronde*.

What the differences between these sorts were, does not appear ; whether in leaf or bark, or manner of culture. And I must observe, that in all the specimens in the British Museum I could observe no difference of species. But this is to be understood, that every sort coming from Ceylon is, by the Dutch and by the shops, called Cinnamon ; and that of our own growth is by them always called Cassia. The reason is obvious.

The specimens, which I now produce, of the Canella or bark of the Cinnamon of Sumatra, I procured in the year 1755. from Mr. Tho. Combes, a gentleman then in the service of the East India Company in Sumatra, by means of a friend.

I was then attempting to form a society for the carrying on a General Natural History, to try proper experiments, and to employ proper painters and engravers suitable to the importance of the subject ; and therefore attempted to establish a correspondence in those parts, whose productions are as yet little known to the public.

I men-



I mention this design, because it would not be possible else to explain what Mr. Combes means by the word *Society*, which he so often mentions in his letter; of which I shall produce an extract, so far as it relates to the present inquiry.

It seemed to me very improbable (as the same plants are generally found in the same latitude and soil), that the spices now in the possession of the Dutch should grow only in that small tract of land, which is in their possession. And I had many credible informations, that, whatever they may pretend to the contrary, this is only a pretence.

I therefore desired to obtain the best information of the nature and culture of the plants producing spices, as well as of many other things, which are foreign from this inquiry.

I desired to know, how the spices were dried and cured; and that different specimens might be sent me of the plants, their seed, flower, leaf, and bark, and properly cured and prepared.

This produced the answer I lay before you herewith, together with the specimens now produced.

You see hereby, that the Dutch dry their Cinnamon in sand; probably to take away that viscosity, which is complained of in the Cassia.

And you will observe also, that the specimen produced dried and cured is also as free from any viscosity, as the Cinnamon of Ceylon: That it agrees also with the Cinnamon in every other quality, and in colour; and that none of the distinctions mentioned by Mr. Ray can be found herein; but that they may arise from the part of the tree, from whence the bark was taken; the inner bark of the large wood being red, as you see by the other specimen produced.

produced. And the common Cassia taken from the larger branches, and not cured, has the viscosity complained of in some degree, tho' much less than it had four years since, when I received it.

Mr. Ray says, that one is weaker in taste, as he supposes, than the other. That may be so from its manner of drying, or keeping of it. Dried in large quantities, and by a stronger heat, it will probably be stronger, than if it is dried in a lesser quantity, and flower.

As for the viscosity, the glutinous part is found in every plant in some degree, as well as in every animal. It preserves the parts from moisture; but will be consumed by heat or time; and it will be a preservative to the plant, till it is destroyed; which was the reason, as I suppose, that Mr. Ray mentions Cassia to have kept good thirty years, the viscosity not having been destroyed by drying.

I suppose the reason, which the Dutch have to dry it, is to make it sooner fit for the market, and possibly fitter for distillation.

You will see from Mr. Combes's letters and specimens, that he thinks there may be two sorts of Cassia or Cinnamon in Sumatra: possibly there may be the same difference in Ceylon; but, if so, I suspect them both to be only seminal varieties, and that their virtues are the same.

Mr. Barlow, some time since a Surgeon in the service of the India company, made a considerable quantity of oil of the Cassia of Sumatra, which was very little, if any thing, inferior to that drawn from Cinnamon; and it was sold to great profit.

If these plants are really the same, or if they are of equal goodness, supposing there was a small difference

ference in the form of the leaf, it might be well worth the attention of the East India company to try to cultivate these plants in the manner they do in Ceylon; that is, to make plantations in a proper soil; and to have regard to the proper distance from the sea of the place, where they try the experiment: for some plants require to be near the sea, and others far from it, in Sumatra; which is the case of the Mango, and Mangosteen; the one of which must be near the sea, the other at a distance from it.

I think the plants should be suffered to grow strong, to be six or seven years old, and then cut every three years, the bark peel'd off and dried in hot sand, and packed close, and kept dry. This I take to be all necessary to be done, to try, if our Cinnamon will not produce as good a price as that of the Dutch.

Perhaps the plants need not stand so long before cut; for the vegetation of plants in hot countries is very great.

There are many other most valuable vegetables in Sumatra, which might be made staple commodities, as fagoe, camphire, several sorts of ginger, rice, and many other, which are foreign to the present inquiry.

But it may not be amiss to recommend it to the traders to Sumatra to bring some quantity of the twig-bark of the true Cassia, well cured; and also to the company, to have a chemist at Sumatra, to extract carefully the oil of Cassia; which is best, and in greatest quantities, produced from the bark of the body, and of the larger branches of the tree: and also that the company would procure an exemption of all customs or duties on Cassia, or on the oil of Cassia, for some time: and also that the college of physicians

physicians in their dispensatory would direct Cassia or Cinnamon of Malabar or Sumatra to be used, instead of the Cinnamon of Ceylon; and that the same should be used by apothecaries and distillers, and in all simple and compound waters, in which Cinnamon is used.

*Extract of a Letter from Mr. THOMAS COMBES,  
dated Fort Marlborough, 5 Jan. 1755.*

**I**N regard to the first article of your paper, now before me, which is the inquiry desired to be made concerning the spices, I am of opinion, that the true Cinnamon grows no-where but on the island of Ceylon, unless Cassia be allowed to be the same tree, which I am inclined to think.

N<sup>o</sup>. 9. contains seeds of the Cassia or wild Cinnamon-tree. As for the seeds of the true Cinnamon-tree, I believe they are very difficult to be got; for as the Dutch are the sole masters of this spice, and get a good deal of money by it, I fancy, according to their usual custom, they have very well guarded against the transplantation of it. I hope however, that these seeds will not be unacceptable to the society, as Cassia itself is of some value; and as I am very doubtful, whether this tree is not the same with the true Cinnamon, being of opinion, that the difference observed in them arises from the different method of curing their barks, or from the taking the bark from different parts of the tree, or at different seasons, or of different ages, or perhaps all these.

I have made inquiry concerning this from some very intelligent persons, and found them to be of

opinion, that the Cassia and Cinnamon-tree were of the same genus. I have inquired further concerning the method of curing it at Ceylon; but as this is done by the natives, the Dutch are not very well acquainted with it; nor could I obtain any good account of it, different people giving me different relations. Some said, it was the inner bark, some the middle, and some the outer; 'tho' of the young branches, they seemed in general to agree, that it was gathered at a certain season of the year, and that one part of the cure was burying it in sand for some time. This may be tried with Cassia, and may perhaps take away that viscosity or glutinous quality observed by chewing it, and which is the principal mark for distinguishing it from Cinnamon. As to their chemical oils, I have heard many people say, that they are not distinguishable otherwise, than that from Cinnamon is generally better, or, as it may be called, stronger, than that from Cassia; and accordingly bears a better price. But the Dutch company's chemist at Batavia, if I may give him this title, informed me, that they are essentially different, and plainly distinguishable. But I must confess myself very doubtful of the knowledge or veracity of this chemist, and strongly suspect, that they are no otherwise different than in goodness, as many other oils drawn from the same subject are.

I observe the price of Cassia is greatly risen in England within these two or three years; but whether this be owing to an increase in the consumption, or a decrease in the importation of this commodity, I cannot say.

The Dutch government of Batavia has this year, in some new regulations of their trade, prohibited to  
all

all persons the dealing in any of the fine quilled sort of Cassia, and declared the same to be contraband, and reserved for their company only; and put it upon the same footing as their Cinnamon.

What reasons induced them to this, I am yet a stranger to; but it makes me suspect, that the rise of this commodity in Europe is owing to some other cause than a deficiency in the importation thereof. Perhaps some discovery has been made rendering Cassia equal to Cinnamon.

In Persia, I think, they make not so great a difference between them as elsewhere; and I myself, for want of Cinnamon here for some months past, made use of the fine quilled Cassia; and the difference I observe between them I imagine to arise rather from the greenness and want of dryness in the Cassia, than any thing else, or perhaps from the method of curing it: for if there happens to be a little too much Cassia put into my chocolate (and other things I use in it), a little bitterish taste arises, something like what we meet with in most barks; tho' I do not remember to have observed this of Cinnamon: but as to its boiling to a jelly, as Quincy mentions, I find no such thing, and think it bears boiling as well as Cinnamon. Nor do I think its distilled water more subject to an empyreuma than that of Cinnamon.

I have inquired of the country people here, who bring it us, and they tell me the finest sort is the inner bark of the small branches; and indeed that it is the inner bark, I think, is evident in Cinnamon as well as Cassia; no outer bark of the youngest branches of any tree having, in my opinion, that smooth surface observable in both these barks.

I once thought, that it was better to take the bark from the body of the tree than from the branches, imagining that the bark from the trunk or body of all-trees must in general be stronger, let its natural taste be what it will, than from its branches. This I find to be so in Cassia; and I have been informed, that the large ligneous pieces of Cassia have afforded rather more oil in distillation than the fine quilled sort, their weight being equal; but upon trial I could not make the bark from the trunk curl or roll up, as it ought to do, owing, as I suppose, to my unskilfulness, or to rigidity, or the natural position of its fibres; for the bark of the younger branches curled of itself, wanting hardly any other assistance than the sun.

I have already observed, that Cassia is found in chewing to have a viscidness, which Cinnamon has not. I have endeavoured to remove this in a little I send you, marked B: pray let me know, if it answers; and be assured, it was taken from the younger branches of the tree, of which I send you the seeds.

I send you also, marked C, some of the bark taken from the same tree; as also some of the leaves, marked D.

I have sent you also a little of the bark of the trunk of a tree, which, tho' called Cassia, seems not to be so, marked E; and also the leaves of the same tree, marked F.

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